# CHICKAMAUGA DAM -
# NAVIGATION LOCK PROJECT

## FINAL ENVIRONMENTAL IMPACT STATEMENT

Tennessee Valley Authority

March 1996

CHICKAMAUGA DAM -
NAVIGATION LOCK PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

Responsible Federal Agency:

Tennessee Valley Authority

Cooperating Agencies:

U.S. Army Corps of Engineers
U.S. Coast Guard
U.S. Fish and Wildlife Service

Alternatives:

(1) Construct new 110 x 600 foot lock (preferred alternative).

(2) Permanently close existing lock (no action alternative).

(3) Construct new 60 x 360 foot lock (replacement in-kind).

(4) Construct new 75 x 400 foot lock.

Location:

Hamilton County, Tennessee

Abstract:

The environmental consequences of closing the navigation lock at Chickamauga Dam on the Tennessee River at Chattanooga, Tennessee, and constructing a new lock are analyzed. The analysis includes direct impacts associated with construction and operation, and indirect socioeconomic impacts. Construction impacts would be localized with few additional operational impacts expected. Most impacts related to the action are socioeconomic in nature. Closure of the lock would seriously affect migratory fish species and pose economic concerns for upstream industry. Construction of a new lock has a positive economic benefit.

For additional information, contact:

Mr. W. Gary Brock
Manager, Water Resource Projects and Planning
Tennessee Valley Authority
400 W. Summit Hill Drive, WT 10C-K
Knoxville, Tennessee 37902-1499
(423) 632-8877

## CONTENTS

**APPENDICES**

## LIST OF FIGURES

## LIST OF TABLES

## SUMMARY

This Environmental Impact Statement (EIS) addresses the proposed construction of a new 110 x 600 foot navigation lock at TVA's Chickamauga Dam at Tennessee River mile (TRM) 471.0. Due to "concrete growth," the existing lock is expected to deteriorate to the extent that it will create a safety concern and must be closed. Because of the structural problems and potential safety concerns, the lock will have to be abandoned and plugged with concrete to make the structure a safe water barrier.

TVA must make a decision whether to maintain navigation on the upper Tennessee River by constructing a new lock. If TVA decides to maintain navigation, a decision must be made as to the size of the new lock before the existing lock is no longer operational. Four alternatives were considered as part of TVA's decision:

(1) Construct new 110 x 600 foot lock (preferred alternative).

(2) Permanently close existing lock (no action alternative).

(3) Construct new 60 x 360 foot lock (replacement in-kind).

(4) Construct new 75 x 400 foot lock.

Under the no action alternative, a replacement lock would not be built. This action would eliminate navigation through Chickamauga Dam. Upstream industries dependent upon barge transportation would be forced to shift to truck or rail transport of commodities, and recreational boaters and commercial tour operators would not be able to move between Chickamauga and Nickajack Reservoirs. Plugging the existing lock (no action) is estimated to cost $6.8 million in 1995 dollars for dealing with the structural problems. Environmental impacts associated with the no action alternative include the elimination of the upstream migration of fish species due to lock closure and the loss of 297 miles of navigable waterway.

TVA's preferred alternative would be to replace the existing 60 x 360 foot lock with a new 110 x 600 foot lock. The new lock size would be consistent with locks in place downstream on the Tennessee River. Construction of the new lock is estimated to cost $225 million. After the new lock is completed, the existing lock would then be plugged at a cost of $6.8 million. Total cost of the new lock and closure of the existing lock is $231.8 million, in 1995 dollars. If the new lock is

constructed by the time the existing lock is scheduled for closure, there will be no halt to river traffic.

Environmental impacts associated with construction of a new lock include minor loss of aquatic habitat and resident populations of freshwater mussels, including one listed endangered species (pink mucket, *Lampsillis orbiculata*). These losses would be mitigated by relocating the mussels and possibly by other means to be determined during consultation with the U.S. Fish and Wildlife Service. Disposal sites would be landscaped and vegetated, and potential impacts to a federally endangered plant (mountain skullcap, *Scutellaria montana*) located adjacent to a disposal site would be mitigated through maintenance of a contiguous 250 foot forest buffer zone. A new lock would necessitate the existing historic dam complex to be modified and would, therefore, require a Section 106 review.

Environmental impacts associated with the operation of the new lock include socioeconomic benefits associated with the continuation of commercial and recreational lockages, and the loss of four spillway bays. Through appropriate design of discharge structures, TVA would attempt to minimize potential impact on the upstream migration of certain fish species, such as sauger.

The construction and operational environmental impacts of the smaller 60 x 360 or 75 x 400 foot locks would be similar to the impacts associated with the proposed 110 x 600 foot lock. The larger size lock (110 X 600 feet) was selected as the preferred alternative because of the higher benefit-cost ratio.

After closure of the old lock, shipper savings, both for existing traffic and expected traffic growth, will accrue to the new 110 X 600 foot lock. It is estimated that the benefit-cost ratio of the new project will be 4.3, that is, for each federal dollar spent on the project, $4.30 would be returned to the nation in shipper savings benefits.

This EIS also discusses the use of portage facilities around Chickamauga Dam to support upstream barge use without the construction of a new lock. However, since this use was found to be economically infeasible, it was not evaluated in detail.

Selection of any of the new lock alternatives would allow recreational boaters to continue to navigate between Nickajack and Chickamauga Reservoirs. The larger lock sizes would facilitate more efficient movement of recreational boaters during special events.

TVA issued a draft EIS on May 10, 1995, that considered the option of continued operation of the existing lock. It is now clear, based on information that became available after release of the draft EIS, that the condition of the lock is so serious that this option is no longer available, and the dam will have to be plugged or replaced within the next ten years. Therefore, this final EIS does not consider the alternative to rehabilitate and continue operation of the existing lock described in the draft EIS.

TVA's selection of the preferred alternative (construct new 110 X 600 foot lock) is based on environmental, social, economic, recreational, engineering, and public safety analyses. TVA will monitor the structural integrity of the existing lock until it is closed. Closure is expected to occur in at most ten years. Construction will be initiated five years prior to its closure. TVA will make the necessary repairs to keep the lock in operation as long as possible, while undertaking engineering design work for a new lock. Construction of a 110 x 600 foot lock would have to be initiated five years prior to the permanent closure of the existing lock such that navigation will be maintained on the upper Tennessee River.

## 1.0 Purpose and Need for Action

This Final Environmental Impact Statement (EIS) is intended to provide environmental information to assist TVA in determining whether to maintain navigation on the upper Tennessee River by constructing a new lock at TVA's Chickamauga Dam. Alternatives under consideration include the no action alternative of closing and plugging the lock with concrete, and three other alternatives involving the building of a new lock at the site. Alternatives for a new lock at Chickamauga Dam include one with overall dimensions of 60 x 360, 75 x 400, or 110 x 600 feet. A 60 x 360 foot lock would maintain the status quo at the project. A 75 x 400 foot lock would marginally increase lock capacity over the 60 x 360 foot lock; while a 110 x 600 foot lock would bring the Chickamauga project into conformance with downstream locks on the Tennessee River where the 110 x 600 foot is the standard lock size.

### 1.1 Location and Project Characteristics

Completed in 1940, Chickamauga Lock and Dam is located at mile 471.0 on the Tennessee River, about 13 miles upstream from the Port of Chattanooga, Tennessee. Figure 1 shows the existing 60 x 360 foot lock, spillway, and powerhouse at Chickamauga Dam. Figure 2 is an artist's rendering of the existing site with the position of the dam, lock, North Chickamauga Creek, and infrastructure on site. Shown also in Figure 2 is the confluence of North Chickamauga Creek with the Tennessee River at a point just below the lock's lower land approach wall. The Chickamauga Dam project consists of north and south earth fill embankments (1390 feet and 3000 feet long, respectively), a 111,000 kW powerhouse with four units, an 864 foot long concrete spillway with 18 bays, and a lock which has a maximum lift of 53 feet. Figures 1 and 2 also show the proximity of Lake Resort Drive to the Tennessee River and the Chickamauga project. Upstream movement through the lock is in a northeasterly direction and its proximity to Chattanooga and location with respect to other TVA projects is shown in Figure 3.

Figure 1

PHOTO OF EXISTING CHICKAMAUGA LOCK AND DAM

WITH NEW 110 X 600 FOOT LOCK SUPER IMPOSED

FIGURE 2

ARTIST'S RENDERING OF THE

THE EXISTING CHICKAMAUGA LOCK AND DAM SITE

FIGURE 3

LOCKS AND DAMS ON THE TENNESSEE RIVER

## 1.2 Background

### *Tennessee River and Navigation System*

The Tennessee River is formed at the junction of the Holston and French Broad Rivers near Knoxville in eastern Tennessee. From that point, it flows 652 miles through Tennessee, northern Alabama, the northeastern corner of Mississippi, and western Kentucky and enters the Ohio River at mile 935 near Paducah, Kentucky. The Tennessee River falls a total of 515 feet along its 652 mile length. The fall is gradual over most of the river's length except in the Muscle Shoals area of Alabama where a drop of 100 feet is found in a stretch of less than 20 miles. The river has a drainage area of 40,910 square miles. In addition to the Holston and French Broad Rivers, major tributaries of the Tennessee include the Hiwassee (river mile 599.4) Clinch (river mile 567.6) and Little Tennessee (river mile 601.2) Rivers.

The existing navigation system on the Tennessee River comprises nine multipurpose lock-and-dam projects having a total of 13 locks. Lock chambers on the mainstem system vary in size from the 110 x 1000 foot main chamber at the Pickwick Locks and Dam to the 60 x 300 foot two-stage auxiliary lock chambers at the Wilson Locks and Dam. Only four of the Tennessee River projects--Pickwick, Wilson, Wheeler and Guntersville--have operating main and auxiliary locks. The Barkley Lock on the lower Cumberland River functions as an auxiliary lock for the Kentucky Lock since the Barkley Lock is accessible to Tennessee River traffic through the Barkley Canal.

Navigation pools on the Tennessee River range in length from 16 miles between Wilson and Wheeler Dams to 184 miles between Kentucky and Pickwick Dams. The mainstem pools provide a nine foot navigable channel along the entire 652 mile length of the Tennessee except for a three mile stretch at Knoxville where the depth diminishes to six feet. In addition, the mainstem pools back up water in tributary streams and embayments creating over 300 miles of navigable tributaries.

The upper Tennessee River segment consists of the three navigation reservoirs formed by the Chickamauga, Watts Bar, and Fort Loudoun Dams. This river segment begins at river mile 471.0, the site of the Chickamauga Lock and Dam and extends 181 miles to river mile 652.0, the confluence of the Holston and French Broad Rivers at Knoxville. The Clinch and Emory, Hiwassee, and Little Tennessee Rivers are the major navigable tributaries to the upper Tennessee segment. Limited backwater navigation is also available on some other tributaries, including Soddy Creek, Piney River, King Creek, Little River, and French Broad River.

### *Commercial Navigation*

The predominant commodities trafficked on the upper Tennessee River (essentially the lock traffic) are asphalt, grains, ores and minerals, and forest products. The asphalt traffic moves to terminals in Knoxville, Tennessee, for distribution to east Tennessee, southwest Virginia, and western North Carolina. Grains traffic involves corn and animal feed. Ores and minerals traffic is comprised of outbound zinc concentrate, and inbound salt destined for regional distribution as road salt and as input into the manufacture of chlorine gas. Forest products are inbound wood residue from a sawmill in Alabama and outbound paper products for distribution by barge as far away as Omaha, Nebraska. Iron and steel traffic is comprised largely of inbound finished steel and outbound semi-processed steel, alloys, and scrap. Chickamauga Lock currently has a traffic level of about 2.1 million tons.

The 2.1 million tons of traffic does not currently include any appreciable coal movement. However, a larger lock at Chickamauga Dam is expected to be used by southeastern utilities to meet the standards required under Phase II of Title IV of the Clean Air Act. This coal is in deep mines in eastern Kentucky and would move via rail carriers to a site in the Chickamauga pool where it would be loaded onto barges for movement down the Tennessee-Tombigbee Waterway to utility consumption. Construction of the new lock at Chickamauga Dam would give southeastern utilities a more economical transportation option to help meet the mandates of federal clean air legislation.

### *Concrete Growth at Chickamauga*

Concrete growth is caused by a reaction between the alkali in the cement and the aggregate rock which results in the physical expansion of concrete structures. Over the years repairs and modifications have been made to the hydro power units, spillway gates, and lock at the Chickamauga project to alleviate problems associated with concrete growth.

The Chickamauga project has suffered from the effects of concrete growth since shortly after completion in 1940. Initially, surface cracking developed in the spillway deck and a portion of the navigation lock and eventually spread over most of the project. At the lock, major structural cracks developed in the chamber and approach walls and have required extensive repairs (see Figure 4). Instrumentation was also installed to monitor structural movements and internal stresses.

In 1995, TVA completed a three-dimensional computer model study called finite element analysis, to evaluate the condition of the powerhouse, spillway, and lock. The results of this analysis have caused considerable concern about the long-term structural integrity of the lock and indicate that the lock has a limited life expectancy, estimated to be at most ten years. Failure of the lock would close the upper Tennessee River to commercial navigation and may have dam safety implications as well, including partial loss of Chickamauga Reservoir and interruption of water intake supplies.

### *Lock Repairs and Maintenance*

Extensive structural repairs and maintenance activities have been necessary over the past 30 years to alleviate problems resulting from concrete growth at the lock. Expansion has caused the upper river approach wall to move in the upstream direction, cracking the wall's support piers. In 1965, three vertical slots were cut in the wall to decrease stress in the concrete. Tensioned steel bars were used to strengthen the support piers, and the cracks in the concrete were grouted. By 1977, the expansion slots had closed due to continued concrete growth, and the three slots were recut in 1979-1980. A fourth slot was also added, and additional steel bars were installed in the support piers.

In 1977, the lower river approach wall was found to be moving downstream. A slot was cut in the wall to isolate it from the lock. Also, in 1977, extensive cracks were found in the piers between the discharge ports in the lock's lower river wall. These cracks were repaired in 1982 by drilling vertical holes from the deck of the lock through the piers between the discharge ports and grouting steel bars into the holes. The cracks were also grouted.

Page for Figure 4

CRACKS IN THE LOCK WALL AT CHICKAMAUGA LOCK AND DAM

Exploratory drilling in 1983 identified cracks throughout the lock's river and land walls. Extensive cracking was found in the two blocks adjacent to the river leaf of the downstream miter gate. These two blocks were repaired in 1984 with post-tensioned tendons installed from the deck into bedrock. Steel bars were also installed in one of the blocks from the chamber face, and all the cracks were grouted.

Instrumentation showed that the block supporting the river leaf of the upstream miter gate was moving upstream and toward the river. This block was post-tensioned in June 1995.

Over the years, several operational maintenance activities have also been required due to concrete growth. These have included realignment of the lock's miter gates, filling and emptying valves, and floating mooring bitts. The concrete surface has been repaired and electrical conduits, water pipes, and air lines have been relocated.

Two significant events in 1995 indicate that concrete growth continues to cause structural and operational problems at the lock. In June, the lower land wall gate hinge assembly failed, causing an unscheduled lock closure for repairs (see Figure 5). And, in July, additional movement of the upper river approach wall was observed.

A comprehensive action plan is being developed to stabilize the lock structure in fiscal years 1996 through 2001. Activities will include anchoring the concrete blocks to bedrock with post-tensioned tendons, installing steel shear reinforcing bars in the blocks, and providing additional instrumentation and monitoring of the structure.

The capability of keeping the lock operational and maintaining it as part of the project's water barrier will be evaluated annually. It is anticipated that the lock will have to be closed for navigation within the next ten years and a concrete plug installed in the lock chamber to ensure dam safety.

FIGURE 5

DAMAGED HINGE CONNECTION ON THE LOWER MITRE GATE
AT CHICKAMAUGA LOCK AND DAM

### *Lock - Dam Safety Concerns*

The lock is part of the water barrier at the Chickamauga project. Because of the lock's dam safety implications, TVA presented its findings to the Board of Hydro Consultants[1] on July 12, 1995. The hydro consultants endorse the need for immediate repairs and agree that the lock's life is definitely limited. They also indicated that there is an increasingly urgent need for action to ensure structural integrity and continued operation without threat to public safety.

Allowing the lock to fail is not a viable alternative. Failure would disrupt the water intakes at TVA's Sequoyah and Watts Bar Nuclear Plants, as well as municipal and industrial water supplies. While the supply of water at the nuclear plants would not be in jeopardy, loss of the pool level in Chickamauga Reservoir would increase the water temperature in the reservoir. Treated sewerage discharge could also be impacted. Access from the main channel to private docks would not be possible. Barges and towboats would also be stranded upstream from Chickamauga Dam. The total number could be as great as 150 barges and six towboats which could not be easily removed.[2] There could also be potential damage to hulls such that cargo could be lost. Damage could also occur inside the lock chamber if occupied during a failure, depending on the nature of the failure. Failure could range from loss of a gate leaf, to movement of a block, to lock wall collapse such as occurred at TVA's Wheeler Lock in the early 1960s. Lock occupancy during a lock wall collapse could result in substantial property damage, cargo spill, and possible fatalities.

### *Lock Closure*

The determination that Chickamauga Lock could not be operated beyond a ten year period was made in the summer of 1995. Prior studies assumed that the lock would continue to

[1] The TVA Board of Hydro Consultants are two professional consulting engineers who are respected throughout the civil engineering industry for their experience and expertise on locks, dams, and related facilities. These individuals are Thomas M. Leps, P.E., and Robert B. Jansen, P.E.

[2] Removal of barges and towboats by an overland route would not be likely due to their size. The towboat, *Casey Keasler*, for example, which operates above Chickamauga Dam is 83 x 26 feet, and the open hopper barges in use above the lock are 35 x 195 feet. The principal impediment to removal would be the significant cost which would include engineering design, dry-docking, and utility removal and reinstallation.

operate and addressed the issue of the desirability of navigation improvements at Chickamauga or elsewhere on the upper Tennessee River.

TVA and the U.S. Army Corps of Engineers (USACE) began studying the navigation problems on the upper Tennessee River in 1987. The Nashville District of USACE (1988) released the study results in the publication, *Commodity Traffic and Benefit Study for Navigation Improvements on the Upper Tennessee River*. Both agencies agreed that the small and aging locks on the upper Tennessee River--Chickamauga, Watts Bar, and Ft. Loudoun--were constraints to navigation and that concrete growth at Chickamauga threatened that lock's continued usefulness. The 1988 study examined the feasibility of increasing their size to 110 x 600 feet and thus bringing them into conformance with locks below Chickamauga on the lower Tennessee River. The study concluded, however, that the benefits would not be great enough to justify the cost of three new locks on the upper Tennessee River, and TVA transportation planners then concentrated on improvements at only Watts Bar and Chickamauga Locks.

The results of the study of lock improvement benefits at Chickamauga and Watts Bar Dams were presented in the USACE report (1993) *Upper Tennessee River Navigation Improvement Study Navigation Systems Analysis* which was produced on contract for TVA. The focus of this study was to estimate benefits that would accrue from a new 110 x 600 foot lock at Chickamauga which would be constructed before the existing lock was closed for an 18 month rehabilitation. At that time, engineering data indicated that the lock could be rehabilitated and function as an auxiliary lock there. It was concluded that if any capacity constraints occurred at Watts Bar Lock, nonstructural measures could be used to control the situation.

### 1.3 Public Review Process

TVA published a notice of intent to prepare an EIS for the Chickamauga Lock project on January 11, 1991 (56 FR 1216). Notice of availability of the draft EIS was published in the *Federal Register* on May 19, 1995 (60 FR 26882). Copies of the draft EIS were issued prior to publication of the Notice of Availability. TVA, in conjunction with the cooperating agencies, held a public meeting on May 18, 1995, at Chattanooga State Technical Community College to receive comments on the draft EIS. About 60 people attended the meeting including representatives from industry, the public, state and local government, congressional staff, U.S. Department of Energy, U.S. Coast Guard, U.S. Fish and Wildlife Service, and U.S. Army Corps of Engineers. In addition, TVA has received written comments from federal, state, and local agencies, and industry. Written comments were also received from individuals and special interest groups. The majority of comments supported the replacement of the Chickamauga Lock. The main environmental concerns expressed were increased timber harvesting, water quality, and aquatic biology impacts and flood control. As appropriate, responses to comments have been incorporated in the text of the EIS. Comments and responses are presented in their entirety in Appendix B.

### 1.4 Consultation and Required Permits

Construction of a new lock would necessitate obtaining federal, state, and local permits. Anticipated permits and other approvals include:

- National Pollutant Discharge Elimination System (NPDES) permits (see Section 4.5.1.1)
- U.S. Army Corps of Engineers Section 404 permits (see Section 4.8.1.1)
- State Water Quality permits (see Section 4.5.1.2)
- U.S. Coast Guard bridge (see Section 2.1.1)
- Spill Prevention Control and Counter-Measures (SPCC) (see Section 4.5.1.1)
- Air Quality (see Section 4.6)
- Solid Waste Disposal (see Section 4.5)
- Sediment and Erosion Control (see Section 4.5.1.1)
- Road Relocation (see Section 2.1.1)
- National Historic Preservation Act - Section 106 review (see Section 4.11.1.1)
- Section 7 - Endangered Species Act (see Section 4.10)
- No Rise Certification for Compliance with Chattanooga Floodplain Regulations (see Section 4.13)

## 2.0 Alternatives Including Proposed Action

This section describes four alternatives to replace the existing lock at Chickamauga Dam because of concrete growth and summarizes the environmental consequences and benefit cost analysis of those alternatives. As discussed in Section 1, TVA within the next ten years must close the lock. To close the existing lock, a concrete plug would be poured into the lock chamber to form a permanent water barrier and assist in maintaining the structural stability of the dam. This action must be undertaken by TVA because if concrete growth continues, partial loss of control of the upstream reservoir could result. Plugging the lock is defined below as TVA's no action alternative.

The alternative of taking absolutely no action is unacceptable because of the deteriorating nature of the lock and implications for dam safety and navigation discussed in Section 1. Other alternatives include: construct new 110 x 600 foot lock (preferred alternative); construct new 60 x 360 foot lock (replacement in-kind); and construct new 75 x 400 foot lock.

## 2.1 Description of Alternatives

### 2.1.1 Construct New 110 x 600 Foot Lock (Preferred Alternative)

TVA's preferred alternative is to maintain and improve navigation at Chickamauga Dam by initiating construction of a 110 x 600 foot lock at the project five years before the existing lock is decommissioned. This alternative would allow the new lock to be opened for service before the closure of the existing lock.

The 110 x 600 foot lock represents the general standard for locks on the lower Tennessee River. Shown in Table 1, the 110 x 600 foot lock is in place at Kentucky Lock and Dam, the auxiliary lock at Pickwick Lock and Dam, Wilson Lock and Dam, Wheeler Lock and Dam, Guntersville Lock and Dam, and the auxiliary lock at Nickajack Lock and Dam which serves as the main lock at this facility.[3] The size of the 110 x 600 foot lock is well suited for the barges in general use today. Eight jumbo barges can be locked with the towboat in one lockage, which requires about one hour. At this lockage capacity, about 12,000 tons of dry cargo can be processed in one lockage in a 110 x 600 foot lock. Similarly, a standard liquid tow of three barges can also be processed in one lockage.

[3] The main lock at Nickajack Lock remains unfinished.

Table 1
Tennessee River Basin Lock and Dam Structures

| **Project** | **River Mile Location (1)** | **Main Chamber Width/Length** | **Aux. Chamber Width/Length** | **Completion Date** |
|---|---|---|---|---|
| | | | | |
| Kentucky L/D | 22.4-T | 110 x 600 | (2) | 1942 |
| Pickwick L/D | 206.7-T | 110 x 1000 | 110 x 600 | 1937 |
| Wilson L/D | 259.4-T | 110 x 600 | 60 x 300(3) | 1927 |
| Wheeler L/D | 274.9-T | 110 x 600 | 60 x 400 | 1934 |
| Guntersville L/D | 349.0-T | 110 x 600 | 60 x 360 | 1937 |
| Nickajack L/D | 424.7-T | 110 x 800(4) | 110 x 600 | 1967 |
| Chickamauga L/D | 471.0-T | 60 x 360 | -------- | 1937 |
| Watts Bar L/D | 529.9-T | 60 x 360 | -------- | 1941 |
| Ft. Loudoun L/D | 602.3-T | 60 x 360 | -------- | 1943 |
| Melton Hill L/D | 23.1-C | 75 x400 | -------- | 1963 |

(1) T = Tennessee River; C = Clinch River
(2) Alternative route available via Barkley Lock (110 x 800)
(3) Double-lift lock
(4) Not completed; construction was halted in 1967

The proposed lock would be located on the riverside of the existing lock and downstream of the existing dam (see the photograph of the existing lock and proposed 110 x 600 foot lock in Figure 1). The downstream location would allow use of the existing spillway dam as an upstream water barrier during construction of the new lock. The riverside location for the new lock would cause the loss of four spillway bays, eventually requiring the removal of four gates and a portion of three concrete piers. Part of the downstream approach wall to the existing lock also would be removed. To provide a downstream water barrier during construction, a sheet pile cofferdam connecting the dam and existing lock would be constructed. A temporary bascule-type drawbridge would be constructed across the lower approach to the existing lock to provide access to the new lock construction site within the cofferdam. After the cofferdam is removed, the bascule bridge would be relocated to provide a permanent access bridge to the new lock. Vertical and horizontal clearances and operational procedures for the bridges would require approval by the U.S. Coast Guard. Upstream and downstream approach walls, 800 feet in length, would be built on the spillway side, with the downstream approach wall extending under and through the Norfolk Southern Railway bridge. Approximately 1000 feet of the navigation channel would be widened immediately downstream of the Norfolk Southern Railway bridge. In addition, a two-mile stretch of the navigation channel through Colwell Bend would be widened. Two new 30 foot diameter mooring cells would be built both upstream and downstream of the new lock. The State Road (SR) 153 bridge across the lock would remain open during construction, and Lake Resort Drive would be relocated. As part of the relocation of Lake Resort Drive, two new bridges would be built, one over North Chickamauga Creek and one for grade separation between Lake Resort Drive and the permanent access road to the North Chickamauga Creek Greenway. Improvements would be made to the intersection of Access Road and Lake Resort Drive. The existing lock operations building would be demolished. The new lock operations building would be a three-level structure with the top level serving as the operations center, the middle level as a visitor area and assembly room, and the lowest level as an electrical equipment and transformer room.

Figure 6 shows the construction site modifications, spoil disposal and "laydown" (temporary storage) areas, road relocations, and access that would be used if a new lock is constructed at Chickamauga Dam. Primary vehicle access to the facility will be by the existing bridge over North Chickamauga Creek. The existing visitor's parking lot adjacent to the earthen dam will be used as part of the construction laydown area. The existing visitor overlook will be removed and replaced by a new overlook adjacent to the existing lock's lower mitre gates. A detailed description of the proposed lock is contained in TVA's engineering study (1996a) entitled *Chickamauga Project Engineering Evaluation of Navigation Facility*.

A new 80-car parking area will be constructed on earth fill adjacent to the overlook. The fill will bring the parking facility up in elevation to allow better access for the physically handicapped and will facilitate better access to the area. The parking lot will be curbed and sidewalks will be provided. A new lock operations building will be located on the land wall of the new lock (see Figure 7, site plan).

A two lane road will connect the Hixson Greenway area to the lock access road. It will pass under relocated Lake Resort Drive using the same bridge provided for construction access to the spoil disposal area. Figure 8 shows the proposed new location of Lake Resort Drive. The traffic counts show that most of the flow from Lake Resort Drive continues onto Access Road

Figure 6

Construction Site Modification

Figure 7

110 x 600 Foot Lock Site Plan

Figure 8

Road Relocation

during the morning peak. Similarly, during the afternoon peak the majority of commuters on Access Road continue eastbound onto Lake Resort Drive. Hence, the new road network would be dominated by an east-west arterial that would cross North Chickamauga Creek over a new bridge. This arrangement would separate the through traffic from the site and was recommended by the Chattanooga Highway Engineering Department. It would allow for temporary closure during construction of the existing bridge over North Chickamauga Creek to the public.

This bridge would become the point of construction access. What little space is available for a batch concrete plant would be maximized by this layout. Access to the spoil site north of relocated Lake Resort Drive would be under a second small bridge.

Regardless of lock size, Lake Resort Drive must be relocated. Construction of the concrete batch plant and support facilities dictate the road relocation.

As part of the preferred alternative, TVA would continue to monitor the structural integrity of the existing lock until 2005, at which time (or sooner if conditions dictate), the lock would be closed to navigation. This action would make the structure a safe water barrier. Once the lock was closed, a portion of the lock chamber and the associated wall culverts would be plugged with concrete. The upper and lower mitre gates would be removed. Walls would be strengthened by post-tensioning, and wider slots would be cut in the approach walls to prevent problems from continued concrete growth. Miscellaneous equipment and buildings would be removed. No cofferdams would be required; however, installation of needle dams (similar to a cofferdam but more temporary) and dewatering of the chamber by USACE would be required.

### 2.1.2 Lock Closure (No Action Alternative)

Under this alternative, no new lock would be constructed. As with the preferred alternative, the existing lock would continue to be monitored for structural integrity and eventually closed as discussed above in the previous section.

### 2.1.3 Construct New 60 x 360 Foot Lock (In-kind Replacement)

Under this alternative, TVA would construct a 60 x 360 foot lock to maintain the status quo at Chickamauga Dam. As shown in Table 1, 60 x 360 foot locks are currently in place at Watts Bar and Ft. Loudoun Dams. Project design, engineering, and site modifications are basically the same as for the larger 110 x 600 foot lock. Construction laydown and disposal areas would be similar to those discussed for the larger lock.

### 2.1.4 Construct New 75 x 400 Foot Lock

Under this alternative, TVA would construct a 75 x 400 foot lock, identical to the one in use upstream at Melton Hill Dam on the Clinch River. This size lock was suggested by a member of the Tennessee River Valley Association at the draft EIS public hearing on May 18, 1995, and in a subsequent letter dated June 8, 1995. Project design, engineering, and site modifications are basically the same as for the larger 110 x 600 foot lock. Construction laydown and disposal areas would be similar to those discussed for the larger lock.

### 2.1.5 Alternatives Not Considered in Detail

In addition to the alternatives discussed above, TVA also considered other alternatives but eliminated them from further consideration.

#### *Continued Operation of Existing Lock*

This alternative is unacceptable because of the deteriorating nature of the lock and implications for dam safety and navigation discussed in Section 1. Until the summer of 1995, TVA thought that the existing lock at Chickamauga could be rehabilitated as discussed in the draft EIS. This is no longer an option due to concrete growth.

### *Portage System*

In this alternative, TVA would build a road and the necessary terminal facilities such that traffic could be shipped around Chickamauga Dam. Such a traffic management system would require short truck hauls, two cargo transfers, and some storage at the site. For this portage system to be useful, transportation costs for those commodities projected to use the upper Tennessee River must be lower than that available on competing modes. Data given in Appendix D show that portage at the lock would not be economically viable due to transportation cost. Affected commodities include asphalt and zinc ore which would not use the portage system because of the high transportation cost. Additionally, transshipment results in product shrinkage for zinc shippers, which further raises their transportation cost.

### *Larger Lock Sizes*

Other lock sizes—larger than 110 x 600 foot—were not considered because the projected traffic level would not support larger lock sizes. The projected traffic for the year 2050 is 21 million tons which can be processed easily at a 110 x 600 foot lock. The 60 x 360 and 75 x 400 foot locks were appropriate for examining smaller lock alternatives.

## 2.2 Methodology for Comparing New Lock Alternatives

Benefit-cost ratios are used to prioritize and rank water projects for federal funding. This basic methodology is laid out in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (U.S. Water Resources Council, 1983). The guideline compares annual net benefits to annual net cost to determine the ratio of the two components. Generally, in new lock replacement projects, the existing lock continues to accrue benefits up to its capacity which can then be expanded to include gains from nonstructural alternatives such as helper boats.[4] However, in projects such as Chickamauga Lock and Dam where the existing lock must be closed, no benefits accrue to the existing lock. Thus, benefit-cost ratios in closure scenarios are larger than generally found in water projects feasibility studies. The proposed new 110 x 1200 foot lock at Kentucky Dam, for example, has an estimated benefit-cost ratio of about 2.4.

[4] Helper boats assist tows in getting through lock chambers faster than would ordinarily occur and, thus, increase lock capacity.

In the determination of the positive and negative environmental impacts, the potentially affected environments were cataloged and examined using a variety of methodologies. The results are presented in tabular form later in Section 2, and the methodologies are provided in detail in Section 4.

## 2.3 Comparison of Alternatives

### 2.3.1 Benefit-Cost Analysis

The benefit-cost analysis of lock construction at Chickamauga Dam is based on a TVA (1996b) study *Upper Tennessee River Navigation Improvement Study: Chickamauga Lock and Dam Economic Benefit and Cost Analysis* (hereafter the "Economic Study"). The benefit to cost ratios of the three lock sizes are shown in Table 2. The preferred alternative, the 110 x 600 foot lock, has an estimated benefit-cost ratio of 4.3, as compared to a value of 2.5 for the 60 x 360 foot lock and for the 75 x 400 foot lock. The concept of a benefit-cost ratio is not applicable to the no action alternative. Table 3 shows a comparison of noneconomic factors associated with the four alternatives.

The benefit-cost ratio for the 110 x 600 foot lock is considerably larger than the value of 2.5 estimated for both smaller lock sizes. Comparable estimates for the 60 x 360 and 75 x 400 foot locks reflect the fact that transportation savings per ton are greater for the 60 x 360 foot lock due to a different commodity mix. While savings per ton are greater for the smaller lock, traffic is lower there due to a smaller capacity. Construction costs for the 75 x 400 foot lock is $25 million greater than for the 60 x 360 foot lock alternative. These ratios are discussed in detail in the Economic Study.

A benefit-cost ratio of 4.3 implies that the project returns to the nation $4.30 for every dollar invested in the project. The net benefits component of the ratio are the savings

Table 2

Economic Considerations for the Four Alternatives

| Economic Considerations | 110 x 600 Feet | No Action | 60 x 360 Feet | 75 x 400 Feet |
|---|---|---|---|---|
| | | | | |
| Benefit-Cost Ratio | 4.3 | undefined | 2.5 | 2.5 |
| Average Annual Benefits—NED (millions) | 100.0 | 0 | 36.2 | 42.1 |
| Construction Cost—Total (millions) | 225 | 6.8 | 135 | 160 |
| Capacity (million tons) | 35.7 | 0 | 4.7 to 6.6 | 8.3 to 11.0 |
| Tons in 2050—millions | 21 | 0 | 5 | 8 |
| Regional Income Effect (millions) | increase unknown | $ 970 reduction | increase unknown | increase unknown |
| Region Employment Annual Effect | increase unknown | 1624 reduction | increase unknown | increase unknown |
| Firms lost/gained | increase unknown | 4 firms lost | increase unknown | increase unknown |
| Construction Annual Employment | 467 | unknown to plug | 467 | 467 |
| Construction Annual Income (millions) | $16.7 | unknown to plug | $16.7 | $16.7 |
| Years of Construction Activity | 5 | unknown to plug | 3.5 | 4 |
| Impact of Barge Competition on Railroad Rates (millions) | rates decline by $10 plus | rates rise by $10 | rates decline by $10 | rates decline by $10 |
| Annual Power Sale Gain/Loss (millions) | expected Increase | significant reduction--max is $90 | no effect | no effect |
| Construction Gravel Supply (million tons) | slight increase over 2.1 | 2.1 lost | maintain status quo | maintain status quo |
| Low Cost Asphalt Supply (millions) | declining cost | local government cost rise by $1 | maintain status quo | maintain status quo |
| Recreation Annual Value to Public (millions) | $1.8 to $8.0 | lost value to boaters of $1.8 to $8.0 | $1.8 to $8.0 | $1.8 to $8.0 |
| Recreation Special Events | maintain status quo | severely disrupt | maintain status quo | maintain status quo |
| National Security | status quo | diminished capability | status quo | status quo |
| Abandon Public Investment | status quo | 4 locks abandoned | status quo | status quo |
| Navigable Waterways Reduced | status quo | 297 mile reduction | status quo | status quo |

in shipper transportation cost that new lock construction would generate.  That is, a larger lock makes river transportation quicker and cheaper such that shippers' costs are expected to fall. Ultimately, the efficiencies gained through all water improvement navigation projects could combine with the forces of competition to produce lower prices for U.S. consumers and a more competitive position for the United States in international markets.  This is the logic for referring to project benefits as National Economic Development (NED) benefits.

It is also well known that new locks generate regional benefits.  However, regional income shifts are not included in the value of annual net benefits.  In evaluating water projects expenditures, a regional income gain due to one project is viewed as a regional income loss in another region(s) such that the gains and losses in regional income sum to zero.

### *Construction Cost*

Construction costs for the four projects are shown in Table 2.  The construction cost of the 110 x 600 foot lock is estimated to be $225 million in 1995 dollars.  The cost data for the 110 x 600 foot lock is a 30 percent (feasibility) cost estimate as documented in the TVA Fossil and Hydro Engineering (TVA, 1996) report *Chickamauga Project Engineering Evaluation of Navigation Facility*.

Cost data for the 60 x 360 and 75 x 400 foot locks are order of magnitude comparisons based on (1) the 30 percent cost estimate and (2) relations between lock size--60 x 360 and 75 x 400 foot locks--to the 110 x 600 foot lock.  Based on similar projects in our system, TVA engineering staff concurred that the order of magnitude estimates are reasonable estimates of direct cost.  The 60 x 360 and 75 x 400 foot locks would cost $135 and $160 million, respectively.

Plugging the lock would be required for all four alternatives.  It is estimated that plugging the existing lock would cost about $6.8 million.

Table 3
Selected Noneconomic Comparative Factors
of the Four Alternatives

| **Factors** | **110 x 600 Feet** | **No Action** | **60 x 360 Feet** | **75 x 400 Feet** |
|---|---|---|---|---|
| Net Diesel Fuel Consumption (million gallons per year) | 14.4 decrease | 2.9 increase | 3.3 decrease | 6.5 decrease |
| Net Particulate Emissions (thousands of tons) | 15.7 decrease | 3.1 increase | 3.6 decrease relative to maintain and plug | 7.0 decrease over maintain and plug |
| Net Accidents | 101.7 decrease | 20.1 increase | 23.5 decrease | 45.6 decrease |
| Net Deaths | 15.5 decrease | 3.1 increase | 3.6 decrease | 7.0 decrease |
| Road Damage and Oil Runoff | substantial repaving alleviated | substantial repaving necessary | does not capture potential traffic | captures some potential traffic |
| Traffic Congestion and Delays | decrease | increase | status quo | status quo |
| Recycling of paper, iron and steel | no effect | possibly limits recycling in upper east Tennessee | no effect | no effect |
| Number of Tows in year 2000 | 1054 | 0 | 380 | 497 |
| Shoreline Erosion | no impact | no impact | no impact | 0 |
| Infrastructure Problems During Construction | none expected | none expected | none expected | none expected |

***Lock Capacity***

The capacity for each lock alternative is shown in Table 2. Lock capacity is a rather abstract concept and depends on a variety of factors. These include lock use for nonproductive recreational lockages, downtime for maintenance and weather problems (such as fog, high currents, and wind), tow configurations, and age, among others. As discussed in the USACE document (produced on contract for TVA*) Upper Tennessee River Navigation Improvement Study Navigation Systems Analysis* (USACE, 1993, p. e-29), the 110 x 600 foot lock would be rated at 35.7 million tons as a single lock at the dam

Capacities for the 60 x 360 and 75 x 400 foot locks have been studied by USACE on occasion. In the *Upper Tennessee River Navigation Improvement Study Navigation Systems Analysis* (USACE, 1993) commissioned by TVA, the 60 x 360 foot lock was rated at 6.6 million tons. In another study the 75 x 400 foot lock was rated at 11.6 million tons. The explanation for the relatively low capacity of the 60 x 360 foot lock chamber at Chickamauga is that, while adequate for the towing industry when constructed, jumbo barges (195 x 35 feet) can only be processed singly in the small lock chamber.[5] A seven barge general cargo tow requires about seven hours for processing. Here, the towboat locks through with the last barge. A three barge asphalt tow requires an extra hour per lockage due to the fact that the 60 x 360 foot lock chamber cannot accommodate an asphalt barge and a tow boat simultaneously.

The 400 foot chamber would be an improvement for locking dry cargo in jumbo barges. A seven barge tow can be processed in two lockages which would require two hours—four

---

[5] The small locks originally constructed upstream from Pickwick Dam, including the upper Tennessee locks, were designed by the USACE in the late 1920s and based on the following criteria: (1) the standard barge in use at that time measured 26 x 175 feet; (2) the power of pushboats in use at that time limited most tows on the system to four barges, which could be locked through a 60 x 360 foot chamber at one time; and (3) most of the cargo shipped on the Tennessee River initially was expected to move between industrial plants at Muscle Shoals and the Ohio River. When TVA assumed responsibility for the Tennessee River in 1933, its decision to continue building small locks at Guntersville, Chickamauga, Watts Bar, and Fort Loudoun was greatly

barges in one lockage and three barges plus the towboat in the second lockage. However, the 400 foot lock is not adequate for liquid barges. Liquid asphalt barges, 250 feet in length, can only be processed singly in the 400 foot chamber, and a standard three barge tow would thus require four hours for processing. These inefficiencies are responsible for the lower locking capacity of the 400 foot lock as compared to the 600 foot lock.

While the NED calculations used in this final EIS use the USACE capacity estimates, it is possible that the estimates for the 60 x 360 and 75 x 400 foot lock capacities are more realistically rated at 4.7 and 8.3 million tons, respectively. These are based on TVA calculations. However, the final EIS uses the higher estimates based on USACE simulations.

The estimated tons moved in the 110 x 600 foot lock total 21 million by the year 2050. For the 60 x 360 foot lock, tonnage is forecast to reach 5 million tons, and tonnage at the 75 x 400 foot lock is forecast to reach 8 million tons.

### 2.3.2 Comparison of Environmental Consequences

Important environmental impacts associated with the various alternatives include:

1. Environmental impacts of a shift to land transport of goods as a result of lock closure would include increased fuel consumption, associated air pollution, increased costs for road maintenance, and public safety risks.

2. Dredging of the navigation channel in the tailwaters of Chickamauga Dam during construction would require the relocation of resident mussels to a suitable habitat.

3. The movement of migratory fish species between Chickamauga tailwater and Watts Bar tailwater would cease under the no action alternative. New lock construction could potentially improve hydrologic conditions for fish migration through appropriate design of lock discharge structures.

---

influenced by the existence of small locks at Wilson and Hales Bar Dams and the small

4. Because the Chickamauga Dam project is over 50 years old, a Section 106 review must be conducted for changing design features of the Chickamauga Dam complex.

5. Local temporary increases in downstream turbidity could result during lock construction and dredging. Further, there exists the potential for point source discharges from settling basins and spoil disposal areas.

6. Loss of existing dam spillway bays upon operation of the new lock would not adversely impact TVA's ability to control flood events up to the 5500 year flood event.

7. Lock closure will result in the abandonment of 297 miles of navigable inland waterway and the loss of the public's investment in three locks above Chickamauga.

8. The loss estimated as a result of lock closure is $25.0 million per year of NED shipper savings benefits. This equates to $324.0 million in perpetuity.

9. Lock closure would result in the potential loss of over 800 jobs at ASARCO and A. E. Staley Company, and the loss of about 1600 service sector jobs through the multiplier effect.

10. Lock closure would result in a payroll loss in upper east Tennessee of $75 million per year or $970 million in perpetuity.

11. Lock closure would cause a general rise in regional transportation rates due to elimination of the competitive barge alternative.

12. Separation of the Oak Ridge facility and other industry from access to barge transportation could result in lost opportunities for industrial expansion, and at Oak Ridge, the inability to move certain national defense equipment there for maintenance and repair.

---

Wheeler Lock then under construction by the USACE.

13. Lock closure would result in the closure of two public terminals with a loss of approximately 70 jobs and the abandonment of a $1.5 million investment.

14. Building of a new 75 x 400 or a 110 x 600 foot lock would result in more efficient and reliable movement of recreational boaters through the lock when large concentrations of boaters gather at the lock during special events.

15. Local temporary increases in noise levels would occur during construction as a result of blasting, drilling, jackhammering, and heavy equipment operation.

Environmental impacts associated with the various alternatives are compared in Tables 4 (construction impacts) and 5 (operational impacts).

### 2.4 The Preferred Alternative

TVA's preferred alternative is to construct a new 110 X 600 foot lock in order to maintain and improve navigation at Chickamauga Dam. TVA will make the necessary repairs to keep the lock in operation as long as possible, while undertaking engineering design work for a new lock. Based on engineering studies, closure is expected to occur within at most ten years. Construction of a 110 x 600 foot lock would be initiated five years prior to the permanent closure of the existing lock such that navigation will be maintained on the upper Tennessee River.

Continued operation of the existing lock beyond a ten year period is not a viable alternative because of the deteriorating nature of the lock and implications for dam safety and navigation. The only viable options are either to plug the lock or to replace it. Plugging the lock would result in the abandonment of 297 miles of navigable inland waterway and the public's investment in three locks (Watts Bar, Ft. Loudoun, and Melton Hill) above Chattanooga. The loss of commercial traffic on the upper Tennessee River is estimated to cost the nation $25 million annually. Additionally, fish migration upstream would be blocked if the lock were to be plugged. Moreover, plugging the lock would result in intermodal transportation shifts impacting fuel usage, air pollution, and roadway safety. Having a lock in place at Chickamauga Dam provides shippers in upper east Tennessee, North Carolina, Virginia, and South Carolina a competitive alternative to overland transportation modes and a low cost source of asphalt, salt, and certain other commodities. For these reasons, the no action alternative is unacceptable to TVA.

The 110 X 600 foot lock represents the general standard for locks on the lower Tennessee River and, thus, is well suited for barges in general use today. It is estimated that the benefit-cost ratio from operating a 110 X 600 foot lock will be 4.3, that is, for each federal dollar spent on the project, $4.30 would be returned to the nation in shipper savings benefits. By comparison, the benefit-cost ratios for the two smaller lock sizes is about 2.5. The environmental impacts of the smaller 60 X 360 or 75 X 400 foot locks would be similar to the impacts associated with the preferred 110 X 600 foot lock. In view of these similar environmental impacts but higher benefit-cost ratio, TVA selected the 110 X 600 foot lock as the preferred alternative.

Environmental impacts associated with construction of the 110 X 600 foot lock include minor loss of aquatic habitat and resident populations of freshwater mussels, including one listed endangered species (pink mucket, *Lampsillis orbiculata*). These losses would be mitigated by relocating the mussels and possibly by other means to be determined during consultation with the U.S. Fish and Wildlife Service. Disposal sites would be landscaped and vegetated, and potential impacts to a federally endangered plant (mountain skullcap, *Scutellaria montana*) located adjacent to a disposal site would be mitigated through maintenance of a contiguous 250 foot forest buffer zone. A new lock would have an impact on the existing historic dam complex and will require a Section 106 review. Further, through appropriate design of discharge structures, TVA will attempt to minimize potential impact on the upstream migration of certain fish species, such as the sauger. Additionally, loss of four spillway bays will not adversely impact TVA's ability to control flooding up to a 5500 year flood event.

**Table 4**
**Summary of Environmental Impacts**
**Associated with the Construction Phase**

| | **Alternatives** | | | |
|---|---|---|---|---|
| **Environmental Category** | **110 x 600 Feet** | **No Action** | **60 x 360 Feet** | **75 x 400 Feet** |
| Water Quality | temporary increase in turbidity; potential point source discharges from | temporary increase in turbidity | temporary increase in turbidity; potential point source | temporary increase in turbidity; potential point source |

| | | | | |
|---|---|---|---|---|
| | settling basins and spoil disposal areas | | discharges from settling basins and spoil disposal areas | discharges from settling basins and spoil disposal areas |
| Air Quality | fugitive emissions from construction activities | fugitive emissions from construction activities | fugitive emissions from construction activities | fugitive emissions from construction activities |
| Aquatic Resources (fish migration) | maintain upstream fish migration through appropriate design of lock discharge structures | no upstream migration of certain fish species due to lock closure | maintain upstream fish migration through appropriate design of lock discharge structures | maintain upstream fish migration through appropriate design of lock discharge structures |
| Threatened and Endangered Species | Potential relocation of mussel species | no impact | Potential relocation of mussel species | Potential relocation of mussel species |
| Land Use | road relocation and building of service road and bridges | no impact | road relocation and building of service road and bridges | road relocation and building of service road and bridges |
| Flood Control | lose 6 spillway bays | no change | lose 5 spillway bays | lose 6 spillway bays |
| Wetlands | no expected impact | no impact | no expected impact | no expected impact |
| Noise | low to high levels from construction activities (blasting, drilling, jack-hammering, and heavy equipment operation) | low to moderate increases | low to high levels from construction activities (blasting, drilling, jack-hammering, and heavy equipment operation) | low to high levels from construction activities (blasting, drilling, jack-hammering, and heavy equipment operation) |
| Archaeological | design changes in Chickamauga Dam Complex | no design impacts | design changes in Chickamauga Dam Complex | design changes in Chickamauga Dam Complex |

**Table 5**
**Summary of Environmental Impacts**
**Associated with the Operational Phase**

| **Environmental Category** | **Alternatives** | | | |
|---|---|---|---|---|
| | **110 x 600 Feet** | **No Action** | **60 x 360 Feet** | **75 x 400 Feet** |
| Water Quality | no significant turbidity impact | no impact | no significant turbidity impact | no significant turbidity impact |
| Air Quality Net Particulate Emissions (thousands of tons) | decrease in emissions (particulates, nitrogen oxides and sulfur dioxide) due to intermodal shifts | significant increase in emissions (particulates, nitrogen oxides and sulfur dioxide) due to intermodal shifts | decrease in emissions (particulates, nitrogen oxides and sulfur dioxide) due to intermodal shifts | decrease in emissions (particulates, nitrogen oxides and sulfur dioxide) due to intermodal shifts |
| Aquatic Resources (fish migration) | no significant impact due to increased turbidity from increased traffic | no upstream migration | no significant impact due to increased turbidity from increased traffic | no significant impact due to increased turbidity from increased traffic |
| Threatened and Endangered Species | status quo | no impact | status quo | status quo |
| Land Use | potential marginal industrial development on upstream reservoirs | potential decrease in industrial development and closure of public terminals; intermodal transportation shift | status quo | potential marginal industrial development on upstream reservoirs |
| Strip Mining Damage | none expected | 0 | 0 | 0 |
| Deforestation, Erosion, Etc. | none expected | 0 | 0 | none expected |
| Flood Control | lose 4 spillway bays | no change | lose 3 spillway bays | lose 4 spillway bays |
| Recreation | less lock congestion | no locking of boats through dam | status quo | less lock congestion |

## 3.0 Affected Environment

This section describes the physical, biological, social, and economic resources in the Chickamauga area that could be affected by the proposed action.

### 3.1 Socioeconomics

3.1.1 Population

The Chickamauga Lock project is located in Hamilton County, the center of a metropolitan area. Table 6 contains population data for 1990 and 1980 for the project county, the cities of Chattanooga and Red Bank, plus the state of Tennessee. While Tennessee grew just over 6 percent, Hamilton County lost about 1 percent of its population, dropping from 287,740 to 285,536. The principal city, Chattanooga, lost a considerably larger share, 10 percent, but still contained 152,466 in 1990. Red Bank, the nearest community to the Chickamauga facilities, lost 7 percent, decreasing to about 12,320 in 1990.

3.1.2 Employment and Income

Table 7 contains employment information on the surrounding counties and the state of Tennessee for 1990. Except for the farming sector, Hamilton County mirrors the state's distribution among the major sectors examined. There is a balance among the manufacturing (17 percent), retail trade (19 percent), and service (25 percent) sectors that does not exist in the surrounding counties. Hamilton County has a relatively high per capita income at $21,204 compared to the Tennessee average of $18,283 in 1990.

**Table 6**

**POPULATION AND POPULATION CHANGE**

**TENNESSEE, PROJECT COUNTIES AND SELECTED PLACES**

**1990 AND 1980**

| AREA | 1990 | 1980 | LOSS OR GAIN | PERCENT |
|---|---|---|---|---|
| Hamilton County | 285,536 | 287,740 | -2,204 | -0.8% |
| Chattanooga | 152,466 | 169,514 | -17,048 | -10.1% |
| Red Bank | 12,320 | 13,297 | -848 | -6.4% |
| Tennessee | 4,877,203 | 4,591,120 | 286,083 | +6.2% |

**Table 7**

**EMPLOYMENT DISTRIBUTION**

**FOR SELECTED SECTORS[6]**

**STATE OF TENNESSEE AND HAMILTON, RHEA,**

**AND MEIGS COUNTIES, 1990**

| | Total Emp. | Farm | Construction | Manufacturing | Retail | Service | Government |
|---|---|---|---|---|---|---|---|
| Hamilton | 193,068 | <1% | 5% | 17% | 19% | 25% | 15% |
| Rhea | 13,752 | 4% | 4% | 31% | 11% | 11% | 33% |
| Meigs | 2,574 | 16% | 4% | 33% | 10% | 13% | 15% |
| Tennessee | 2,776,716 | 4% | 5% | 19% | 17% | 24% | 14% |

### 3.1.3 The Labor Market

Strong economic links exist between Hamilton County and its neighboring counties of Bradley, Grundy, Marion, Meigs, Rhea, and Sequatchie in Tennessee; Catoosa, Dade, Walker, and Whitfield in Georgia; and DeKalb and Jackson in Alabama.[7] As a result of these links, the project's income and employment impacts will extend beyond the

[6] By place of work.

[7] These counties, which were chosen based upon commuting patterns enumerated in the 1990 *U.S. Census of Population*, comprise the labor market for the study. At least 300 people from each of these counties commuted into Hamilton County for work in 1990.

Chattanooga area to these neighboring counties, the locations of which are depicted in Figure 9.

Table 8 indicates that 1990 population, income, and employment levels in Hamilton County were much greater than those of its neighboring counties.[8] Within the labor market area, 39.2 percent of the population and 47.0 percent of all employment were located in Hamilton County.

Table 8
Population, Income, and Employment Levels by County
Hamilton County Labor Market Area - 1990

| **State & County** | **Population** | **Per Capita Income (1995$)** | **Employment** |
|---|---|---|---|
| **Alabama:** | | | |
| DeKalb | 54,651 | $14,605 | 27,217 |
| Jackson | 47,796 | 15,976 | 21,979 |
| **Georgia:** | | | |
| Catoosa | 42,464 | 14,367 | 15,250 |
| Dade | 13,147 | 13,178 | 3,968 |
| Walker | 58,340 | 15,199 | 19,949 |
| Whitfield | 72,462 | 19,234 | 57,460 |
| **Tennessee:** | | | |
| Bradley | 73,712 | 17,491 | 40,291 |
| Grundy | 13,362 | 11,784 | 3,729 |
| Hamilton | 285,536 | 21,204 | 193,068 |
| Marion | 24,860 | 14,539 | 8,057 |
| Meigs | 8,033 | 13,463 | 2,574 |
| Rhea | 24,344 | 14,107 | 13,752 |
| Sequatchie | 8,863 | 13,569 | 3,342 |
| **TOTAL** | **727,570** | **$17,951** | **410,636** |

[8] Per capita income levels in Whitfield County, Georgia, however, were almost as high as those of Hamilton County.

Page for Figure 9

In 1990, the overall unemployment rate for the labor market area was 5.4 percent versus a national rate of 5.5 percent. Only five of the labor market counties—Bradley, Hamilton, and Sequatchie, Tennessee; and Catoosa and Whitfield, Georgia—had rates lower than the U.S. average. As Table 9 shows, the area's unemployment rate represented a sizable pool of jobless people—19,394—in the labor market area.

Table 9
Number of Unemployed People by County
Labor Market Counties
1989

| County | Number of Unemployed People | Unemployment Rate (%) |
|---|---|---|
| Alabama: | | |
| DeKalb | 2,002 | 7.5 |
| Jackson | 2,073 | 8.9 |
| Georgia: | | |
| Catoosa | 942 | 4.4 |
| Dade | 357 | 5.7 |
| Walker | 1,766 | 6.2 |
| Whitfield | 2,141 | 5.4 |
| Tennessee: | | |
| Bradley | 1,852 | 4.8 |
| Grundy | 448 | 8.4 |
| Hamilton | 5,786 | 4.1 |
| Marion | 688 | 6.1 |
| Meigs | 375 | 9.9 |
| Rhea | 773 | 7.0 |
| Sequatchie | 191 | 4.7 |
| TOTAL | 19,394 | 5.4 |

For the purposes of this study, the Hamilton County labor market area was narrowed further to obtain the project's likely impact area. Two TVA surveys which documented the residence counties of Sequoyah Nuclear Plant construction workers were used to identify the likely impact area.[9] Counties identified as part of the impact area were Catoosa and

[9]Tennessee Valley Authority. "Sequoyah Nuclear Plant Construction Employee Survey Results, June 30, 1982." Unpublished report, January 1983; Tennessee Valley Authority, Division of Community Services. "Sequoyah Nuclear Plant Construction Employee Survey, September 1978." Unpublished report, September 1980.

Walker in Georgia and Bradley, Grundy, Hamilton, Marion, Rhea, and Sequatchie in Tennessee. The location of each county is shown in Figure 10.

## 3.2 River Traffic and Infrastructure

### 3.2.1 River Transportation

Barge transportation moves certain bulk commodities into and out of the upper Tennessee River area as evidenced by the 2.1 million tons of traffic presently being trafficked at Chickamauga. If moved by overland modes, this material would require 94,000 tractor-semi trailer loads or 210 railroad unit trains.

River traffic is shown in Table 10 below for the year 1989, the base year for estimation of the benefits of a new lock at Chickamauga Dam. These data are discussed in the USACE, 1993, publication *Upper Tennessee River Navigation Improvement Study Navigation Systems Analysis* which was produced on contract for TVA.

Table 10

UPPER TENNESSEE RIVER
TRAFFIC

| **Commodities** | **Barge Traffic (000 Tons)** |
|---:|---:|
| Coal and Coke | 160 |
| Petroleum Fuels | 13 |
| Asphalt | 167 |
| Aggregates | 10 |
| Grains | 527 |
| Chemicals | 84 |
| Ores and Minerals | 540 |
| Iron and Steel | 75 |
| Forest Products | 523 |
| All Others | 58 |
| | |
| **Total** | **2,157** |

figure 10

The predominant commodities trafficked on the upper Tennessee River (essentially the lock traffic) are asphalt, grains, ores and minerals, and forest products. The asphalt traffic moves to terminals in Knoxville, Tennessee, for distribution to east Tennessee, southwest Virginia, and western North Carolina. Grains traffic involves corn and animal feed. Ores and minerals traffic is comprised of outbound zinc concentrate, and inbound salt destined for regional distribution as road salt and as input into the manufacture of chlorine gas. Forest products are inbound wood residue from a sawmill in Alabama and outbound paper products for distribution by barge as far away as Omaha, Nebraska. Iron and steel traffic is comprised largely of inbound finished steel and outbound semi-processed steel, alloys, and scrap.

While 2.1 million tons is presently handled at the lock, traffic is low relative to downstream locks because of long processing times at Chickamauga, Watts Bar, and Ft. Loudoun Locks. The average tow on the upper Tennessee River, which is comprised of 6.7 barges, requires about six and one-half hours for a Chickamauga lockage because the small lock chamber can only process one barge at a time. In a general cargo tow, the towboat locks-through with the last barge. Seven lock-throughs are required to process a seven barge tow. The cost of the towboat including barge rental on the upper Tennessee River averages about $300 per hour. The same situation exists at Watts Bar and Ft. Loudoun above Chickamauga as tows progress upstream toward Knoxville. It is also important to note that demand for lockages by recreational boaters at Chickamauga is very high, consuming up to 40 percent of the effective locking capacity at peak periods in the summer. USACE policy requires that after every third commercial lock-through, a recreational boater is given priority. The lockage of a seven barge commercial tow could thus be interrupted twice for recreational lockages at Chickamauga. This increases the cost of navigating the upper Tennessee River.

The result of these long processing times (and the resultant delays) is a towing charge (exclusive of barge rental cost) that is two to three times the charge that exists below Chickamauga Lock. The so-called “tramp towing rate” for loaded barges below Chickamauga is 2.75-3.0 mills per ton per mile. Above Chickamauga the rate is 6.5-7.0 mills per ton per mile. By comparison, the towing charge on the Mississippi River below Cairo, Illinois, is 1.7-2.0 mills and on the Ohio River is 2.2-2.4 mills. Tramp towing charges vary by commodity, levels of demand that vary by season, and other factors such as the weather. Rates for towing empty barges are lower.

The traffic forecast is primarily dependent on the base year (1989) traffic level and the forecast growth rate. Traffic at Chickamauga Lock has remained relatively constant since 1989 for several years at about 2.1 million tons. River traffic is assumed to be a proxy for transportation services demand in an improved system. However, both USACE and TVA interpret the guidelines such that, where the navigation system is constrained and major structural changes are being evaluated, existing waterway traffic alone is inadequate to identify traffic demands for the improved system. For that reason, market surveys were conducted by the USACE (1993) Ohio River Division (ORD) Navigation Planning Center to better define traffic demands for an improved, unconstrained system. Survey results, adjusted to eliminate double counting and uneconomic movements, raised the base year traffic demand to 8.6 million tons for an improved locking system at Chickamauga. Thus, 8.6 million tons is the traffic that would have been expected in 1989 (and by inference today, since traffic has remained constant since 1989) on the upper Tennessee River if traffic were allowed to move freely up and downstream at Chickamauga Lock and Dam.

The 8.6 million tons forecast to the year 2052 is used as input in the determination of average incremental benefits. The methodology, consistent with that required by the U.S. Water Resources Council's (1983) *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (the guidelines),[10] is divided into noncoal and coal forecasts. For the period 1989-2010, measures of the demand for noncoal barge transportation services are used from TVA's economic forecasts. During the period 2011-2040, the national and regional forecasts are extrapolated with The Bureau of Economic Research (formerly the Office of Business and Economic Research [OBERs]) data (1988 based) and calibrated to match the TVA forecasts through 2010. OBERs growth rates are then used to extrapolate all economic variables to the year 2050. Forecasts of traffic demand are then made using TVA's waterborne commerce econometric simulation model (WECSM) and the economic forecasts. It is important to note that, as is standard USACE methodology, the TVA

[10] The survey and other analyses were performed on contract by USACE for TVA. The study results and methodology are documented in USACE, 1993.

forecast holds constant the economic effects of any transportation rate savings that might accrue to the barge industry given the higher traffic levels forecast in the study.[11]

A summary of projected traffic demands for the upper Tennessee segment and the Chickamauga, Watts Bar, and Ft. Loudoun projects under the base case scenario is presented in Table 11. The traffic base in this table combines both existing upper Tennessee traffic and the estimate of potential traffic that would be attributable to an unconstrained condition on the system. In the base case scenario, traffic demands on the upper Tennessee are projected to more than double over the 61-year forecast period, increasing from 8.6 million tons in 1989 to about 21.0 tons in 2050, representing an annual growth rate of 1.5 percent. Projected growth rates at each of the projects are nearly equal to the system growth rate published in the USACE (1993) forecast of Ohio River Basin waterway traffic.[12]

Approximately three quarters of the base year traffic demand is made up of potential traffic identified by means of the survey. This traffic demand largely consists of potential utility coal traffic and increases in grains, aggregates, ores and minerals, iron and steel, and forest products.

---

[11]As traffic levels rise during the forecast period in response to industrial demand, certain scale economies and competitive effects should put downward pressure on barge freight rates and thus lower them with respect to those of overland modes. At higher traffic levels, unit costs and thus rates are influenced by opportunities for fleeting and the infrequent stranding of barges. Higher traffic levels also suggest more shippers working in the area and thus some downward pressure on rates. More attractive barge rates (relative to rail and truck carriers) should thus attract even more traffic to the river. USACE forecasting models do not attempt to capture the rate-induced impact on river traffic.

[12]See the *Upper Tennessee River Navigation Improvement Study Navigation Systems Analysis,* page 36.

Table 11

PROJECTED TRAFFIC DEMANDS FOR THE UPPER TENNESSEE PROJECTS, 1989-2050
(Thousands of Tons)

| Year | Chickamauga | Watts Bar | Ft. Loudoun | Upper Tennessee System |
|---|---|---|---|---|
| 1989 | 8,606 | 2,646 | 922 | 8,703 |
| 2000 | 10,639 | 3,577 | 1,419 | 10,768 |
| 2010 | 12,914 | 4,159 | 1,624 | 13,073 |
| 2020 | 14,561 | 4,614 | 1,776 | 14,748 |
| 2030 | 16,377 | 5,077 | 1,925 | 16,596 |
| 2040 | 18,424 | 5,584 | 2,088 | 18,680 |
| 2050 | 20,724 | 6,135 | 2,264 | 21,022 |
| Annual Percent Change | 1.5 | 1.4 | 1.5 | 1.5 |

### *Coal Traffic*

As noted, the coal traffic is expected to be used by the southeastern utility industry to meet the standards required under Phase II of Title IV of the Clean Air Act. This coal is in deep mines in eastern Kentucky, and survey data indicate a movement via rail carriers to a site in the Chickamauga pool where it would be loaded onto barges for movement down the Tennessee-Tombigbee Waterway for utility consumption. The 5.0 million tons of low sulfur coal would originate from six counties in eastern Kentucky—Laurel, Clay, Leslie, Harlan, Knox, and Letcher. A TVA transportation rate study (USACE, 1993) demonstrated that this combination of railroad and barge transportation would be too expensive for export of coal through Mobile and, thus, export coal was not included in the forecast data base. Further, there is a surcharge of $1.75 per ton at the Port of Mobile for the loading of coal not mined in Alabama. Even if the rail-barge rate had been more favorable, the Mobile surcharge would have precluded the export of this deep-mined Kentucky coal.

Coal shipments destined for southeastern power plants are forecast for the period 1989-2010 with the Energy Information Administration's (U.S. Department of Energy-DOE) southeastern United States utility coal consumption growth rates. For the post-2010 period, coal traffic projections on the upper Tennessee River are based on a model that relates coal production in the nation to real gross national product. In the forecast, the projected rate for real gross national product declines from the 2.1 percent per year in the pre-2010 period to 1.5 percent per year in the post-2010 period, reflecting lower OBERs economic growth projections. Thus, as in the noncoal forecasting methodology, most of the growth rates built into the economic data reflect the OBERs economic growth projections which are conservative by historical standards. All traffic demand on the inland waterway system that does not move on the Tennessee River system is forecast by USACE which also uses OBERs projections. TVA's *Economic Outlook* (1994) provides a discussion of the national and regional data used to forecast noncoal traffic demand. The *Forecast of Future Ohio River Basin Waterway Traffic 1986-2050* (USACE, 1990) provides a discussion of the USACE forecast of inland waterways river traffic.[13]

### *Forest Products Traffic*

Forest products commodities currently moving on the Tennessee River or having moved there during the recent past include mostly upbound wood by-products, and chips. Outbound products are mostly manufactured newsprint. The bulk of the existing traffic is wood residue moving from the Bowater Southern Paper Corporation's lumber yard near Guntersville, Alabama, to their plant in Calhoun, Tennessee, on the Hiwassee River.

### *Public Terminals*

Two public barge terminals serve upper east Tennessee—Fort Londoun Terminal in Lenoir City, Tennessee, and Burkhart Terminal near Knoxville, Tennessee—located at the mouth of the French Broad River. At these two terminals, there has been a cumulative investment of $1.5 million and an annual employment of 67 workers.

### *Private Industry and Government*

Eight firms ship most of the commodities processed at Chickamauga Lock, and several other large firms have either used barge transportation in recent years, plan to use barge

[13] The USACE forecast document is available from the Ohio River Division Navigation Planning Center, U. S. Army Corps of Engineers, Huntington District, Huntington, West Virginia.

transportation, or maintain the option of using barge transportation as a competitive alternative to overland transportation. Those firms presently using the lock are principal employers in the upper east Tennessee area with 1994 employment levels of 3100. Those firms that use the lock infrequently or only use barge transportation to leverage lower transportation rates from overland carriers employ an estimated 30,000 workers.

Private investment by the companies directly using barge transportation in upper east Tennessee is valued conservatively at $2.4 billion, with annual power purchases from TVA valued at over $90 million. One company alone, ASARCO, has released operational data that indicate an employment of over 500, an annual payroll of $16.5 million, $507,000 in state and local taxes paid, and in-state purchases of $13.5 million, the total direct impact on the Tennessee economy being $30.5 million. It is also important to note that, as a by-product of their zinc mining operation, ASARCO produces 680,000 tons of dolomitic lime, 110,000 tons of 20 mesh masonry sand, and 1.3 million tons of washed stone aggregate. Production of these by-products makes ASARCO the largest supplier of low cost sand and gravel in upper east Tennessee and a large supplier of agricultural limestone in the south.

#### *National Energy and Security Impacts*

The Oak Ridge, Tennessee, Reservation is being offered as a site for the International Thermonuclear Experimental Reactor (ITER). This $10 billion project requires that large pieces of equipment (20 meters weighing 1000 tons) be shipped as part of the project. Oak Ridge cannot be considered for the project without access to barge transportation. Other work at the reservation also requires barge access to move large equipment, with the nature of some of the movements being classified and linked to national defense.

## 3.3 Recreation

### 3.3.1 Area Description

Chickamauga and Nickajack Reservoirs are important recreational resources to the nearby metropolitan area's more than 400,000 residents. Projections for Hamilton and Marion Counties indicate the population base will increase 24.7 percent by 2035. The economic value of recreation development on Chickamauga is estimated to be the second-highest in the Tennessee River system, and Chickamauga ranks third in system-wide reservoir visitation.

The two reservoirs and adjoining land provide over 100 public, commercial, and quasi-public recreation areas with over 30,000 acres of land committed to recreation use. Chickamauga has the greater number of recreation areas, while Nickajack has the larger amount of acreage. The urban population significantly influences water-related recreation activities.

The two reservoirs' 18 marinas typically experience occupancy rates in excess of 95 percent during the recreation season, and several maintain waiting lists for wet and dry slips. Boating access is distributed through 64 developed public and commercial boat access areas. Local governments have completed the first phase of 22 miles of planned riverfront development in Hamilton County. The Tennessee Aquarium which opened in May 1992 surpassed its projected annual visitation of 650,000 in the first four months.

Several heavily used recreation areas are located in the immediate vicinity of Chickamauga Dam. The North Chickamauga Creek Greenway, Tennessee Riverpark, and TVA Chickamauga Dam Reservation recreation and natural areas offer a variety of day use and water-related opportunities. The recreation areas on the Chickamauga Dam Reservation receive the highest use of any in the TVA system.

The city of Chattanooga, Hamilton County, and local organizations are capitalizing on the Chattanooga riverfront developments on Nickajack Reservoir by conducting successful special events that are drawing large numbers of people. The two most successful events, the Riverbend Festival (June) and Annual Fall Color Cruise and Folk Festival (October), attract large numbers of participants and contribute significantly to the high recreation use of the lock during the events. Riverbend Festival had 89,000 paid admissions in 1992, and event sponsors estimate admission sales produced 500,000 visits. The Annual Fall Color Cruise has grown from 10,000 visitors in 1973 to 150,000 visitors during its two-weekend period in 1991. In addition, Christmas on the River (December) is experiencing increased local interest.

### 3.3.2 Water-based Recreation Activities

There are approximately 80 marinas above Chickamauga Lock. These facilities support recreational boating and fishing in the project area.

In 1986, the President's Commission on Americans Outdoors (PCAO) listed the nine fastest growing recreational activities. Of these nine, attending cultural events, sailing, and water-skiing relate directly to the future use of Chickamauga Reservoir. Data from the National Marine Manufacturers Association (NMMA) indicate that demand in boating participation in the United States will also continue to grow. The NMMA's *Boating Industry Report* (1988) estimated that the 1990 projections for 79,000,000 boating participants and 16,000,000 boats owned will grow to 95,000,000 participants and 19,000,000 boats owned by the year 2000.

The Tennessee *State Outdoor Recreation Planning Report* (State of Tennessee, 1990) reflects a continued high interest in several outdoor and water sport recreation activities that will impact the reservoir. Based on the report's household survey, respondents from the Southeast Tennessee and East Tennessee Development Districts (the state's planning districts affecting the lock's impact areas) ranked swimming, fishing, camping, pleasure driving, and picnicking high in latent demand (i.e., public demand for which individuals would most probably increase participation if opportunities were available). Hunting, hiking, and boating/water-skiing activities ranked medium in latent demand. The statewide totals duplicated these responses, with the exception of boating/water-skiing activities, which ranked high. These activities can have a significant impact on boating use, as recreators often combine activities on a visit to a reservoir.

### 3.3.3 Recreation Lockages

In spite of its small size, there were a total of 2344 lockages (a lockage can include more than one vessel) at Chickamauga in 1993. Of the 2344 lockages, 1862 were recreational, 371 were commercial, and 111 were classified as other. Commercial lockages occur 24 hours per day, seven days per week, and are evenly distributed throughout the year. However, according to USACE data (Lock Performance Monitoring System [LPMS] to which TVA has online access) for 1989 through 1993, 95 percent of the recreation lockages at Chickamauga occur during the typical recreation season, April through October. During this period, the highest number of recreation craft use the Chickamauga Lock in June and October, which correlates directly with local special events. Eighty-two percent of the total recreation lockages occur on Fridays, Saturdays, and Sundays.

USACE lock operating procedures routinely allocate every fourth lock-through for recreation vessels when commercial traffic is at the lock. Table 12 summarizes the monthly number of recreation vessels using the lock from 1989 - 1993.

**Table 12**
**Recreation Vessel Lock Use**
**Chickamauga Dam**

| Month | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|
| January | 42 | 7 | 6 | 22 | 26 |
| February | 10 | 7 | 11 | 22 | 24 |
| March | 135 | 32 | 47 | 43 | 41 |
| April | 295 | 155 | 114 | 149 | 148 |
| May | 594 | 463 | 463 | 846 | 695 |
| June | 1502 | 2551 | 1840 | 1499 | 1756 |
| July | 472 | 695 | 271 | 542 | 314 |
| August | 501 | 593 | 114 | 514 | 407 |
| September | 333 | 474 | 320 | 343 | 393 |
| October | 974 | 758 | 835 | 753 | 573 |
| November | 106 | 108 | 66 | 144 | 70 |
| December | 94 | 109 | 9 | 79 | 29 |
| **Total** | **5058** | **5952** | **4096** | **4956** | **4476** |

### *Historical Recreation Locking Patterns*

Lockage of recreation boats followed consistent patterns at Chickamauga during the first three full decades after completion of the lock in the forties. The annual number of boats locking-through at Chickamauga averaged 2396. The decade of the seventies produced increases at the lock, as Chickamauga annually averaged 3301 (plus 38 percent). The decade of the eighties produced another increase for Chickamauga, as the annual average number of boats locking-through increased to 4703 (plus 42 percent from the seventies).

During the recreation season, USACE data (LPMS database) reflect a daily average of 7.9 lockages in 1989 and an 8.8 daily average in 1990. Daily recreation lockages routinely number between 20 and 25 when demand warrants.

### *Recreation Boat Registrations*

According to information from the Tennessee Wildlife Resources Agency, statewide boat registrations increased 54 percent from 120,292 in 1970 to 185,298 in 1980, averaging 5.4 percent per year. From 1980 to 1989, boat registrations increased 26 percent to 233,403, averaging 2.9 percent per year. The combined 19-year span resulted in a 94 percent increase in boat registrations, averaging 4.9 percent per year. The impact areas accounted for 10 percent of the statewide boat registrations in 1988 with the registration of 22,475 boats in Hamilton, Marion, Meigs, Roane, Rhea, and Loudon Counties, those which immediately affect boating on the three reservoirs. Registrations in these counties increased 10 percent from 1984 to 1988. The Chickamauga impact area accounted for 14,030 boats. Tables 13 and 14 provide detailed boat registrations for the impact area.

**Table 13**

**Boat Registrations by County**

**1984**

| Boat Size | Hamilton | Loudon | Marion | Meigs | Rhea | Roane | TOTALS |
|---|---|---|---|---|---|---|---|
| Under 16’ | 6,156 | 1,216 | 830 | 345 | 1,244 | 2,446 | 12,237 |
| 16’ | 1,714 | 237 | 223 | 89 | 233 | 320 | 2,816 |
| 16’ - 26’ | 3,136 | 356 | 156 | 114 | 347 | 648 | 4,757 |
| 26’ - 40’ | 325 | 18 | 16 | 4 | 24 | 60 | 447 |
| 40’ - 65’ | 101 | 21 | 9 | 4 | 9 | 16 | 160 |
| Over 65’ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOTALS** | 11,432 | 1,848 | 1,234 | 556 | 1,857 | 3,490 | 20,417 |

**Table 14**

**Boat Registrations by County**

**1988**

| Boat Size | Hamilton | Loudon | Marion | Meigs | Rhea | Roane | TOTALS |
|---|---|---|---|---|---|---|---|
| Under 16’ | 6,155 | 1,197 | 881 | 347 | 1,208 | 2,388 | 12,176 |
| 16’ | 1,714 | 252 | 251 | 108 | 247 | 355 | 2,927 |
| 16’ - 26’ | 4,225 | 541 | 254 | 168 | 492 | 919 | 6,599 |
| 26’ - 40’ | 401 | 39 | 20 | 6 | 31 | 95 | 592 |
| 40’ - 65’ | 123 | 22 | 6 | 4 | 7 | 18 | 180 |
| Over 65’ | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **TOTALS** | 12,618 | 2,052 | 1,412 | 633 | 1,985 | 3,775 | 22,475 |

Water-based recreation activities contribute to lock usage. Based on the expressed high interest in water-based recreation activities in the state's recreation plan, the NMMA's (1988) estimates that boat ownership and boating participation will continue to grow, and the consistent increases in boat registrations further indicate that recreation boating use of the locks should continue to grow.

### *Future Recreation Locking Demand*

To estimate future recreation locking demand, a relationship between existing lock use data and boat registration data was developed. In addition, historical boat registration data was used to develop a means of predicting future boat registrations. Two points in time were analyzed to establish upper and lower bounds. For the state of Tennessee from 1970 to 1980, boat registrations increased an average of 5.4 percent per year, and from 1980 to 1989 boat registrations increased 2.9 percent per year. These percentages were used to establish an upper and lower bound, respectively, for estimating use until the year 2050, as reflected in Table 15.

**Table 15**

**Estimated Boats Registered in the Impact Area in 2050**

| | Lower Bound | Upper Bound |
|---|---|---|
| Chickamauga Reservoir | 82,600 | 365,700 |

An assumption of future recreation locking demand can be based on the relationship of the average annual number of recreation vessels locking-through each lock compared to the number of registered boats in the impact area. Applying this relationship to the two projected growth ranges of registered boats through the year 2050 identifies minimum and maximum ranges for future recreation lock usage. Table 16 reflects computation data used for projections to the year 2050. (The year 1988 was selected because it was the most recent year with data available for both registered boats by county and recreation vessels locking-through.)

**Table 16**

**Computation Data**

**(Sources: USACE, TWRA, and TVA)**

| | Chickamauga |
|---|---|
| # of Registered Boats - 1988 | 14,030 |
| Recreation Vessels Locking - 1988 | 7,149 |
| --(percent of registered boats) | (51%) |
| Annual Percentage of recreation weekend lockages - 1989 and 1990 | 82% |

Ninety-five percent of recreation lockages occur during the recreation season from April through October. Of these lockages, 82 percent occur on weekends between April and October at Chickamauga. The projected weekend boating use in Table 17 is based on the two annual growth ranges for registered boats in the impact area of 2.9 percent and 5.4 percent. The average number of boats per weekend day was determined by using the current percentage of registered boats locking times the projected number of registered boats times 82 percent (weekend lockages) equals demand for locking divided by 90 weekend days equals average boats per weekend day.

**Table 17**

**Projected Average Boats Per Weekend Day from April Through October from 2000-2050**

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Chickamauga @ 2.9% | 92 | 123 | 163 | 217 | 289 | 384 |
| Chickamauga @ 5.4% | 123 | 208 | 351 | 594 | 1005 | 1700 |

## 3.4 Land Use

### 3.4.1 Reservoir-Wide Area

Chickamauga Reservoir is a navigable impoundment of the Tennessee River in southeastern Tennessee that extends 59 river miles northeast from Chattanooga to Watts Bar Dam. Together with its navigable tributary, the Hiwassee River, this reservoir provides 79 miles of commercially navigable channels.

The physical environment of the project area is strongly affected by its location within the Ridge and Valley physiographic region. Chickamauga Reservoir occupies a relatively broad, flat valley formed by the Tennessee River within a series of northeast-southwest trending parallel ridges. The ridge tops are composed of resistant sandstones and conglomerates averaging about 1000 feet in elevation. The valleys, composed of more easily erodible limestones and shales, are narrow, flat to undulating, and, generally, have been cleared for agriculture and urban development. The Cumberland Escarpment rises abruptly above the western side of the reservoir, forming a sharp separation between the Cumberland Plateau Physiographic Province and the Ridge and Valley Province. The Blue Ridge Mountains rise gradually to the east of the study area. The soils in this part of the Ridge and Valley, generally, formed from limestone, dolomite, sandstone, and shale, are well drained and are predominantly loam with some chert and clay. The erosion hazard is generally slight to moderate for most soils but can be severe (Holiday et al., 1983).

The city of Chattanooga exerts a strong influence on land use in the lower half of the reservoir resulting in extensive development for residential and recreational uses to a distance of about 30 river miles upstream of the dam (Figure 11). The upper portion of the reservoir shoreline is less developed and more rural in nature, dominated by open space, agriculture, and forest. Because of the ridges that parallel the reservoir, access to the shorelines is difficult throughout most of the project area. The major transportation lines follow the valleys paralleling the reservoir in a northeast-southwest direction. Major highways include Interstate 75 and U.S. 11 which parallel the reservoir about ten miles to the east and cross the Hiwassee River near Calhoun, Tennessee.

SR 58 is also on the east side of the reservoir, and U.S. 27 parallels the west side. Railroads follow the same corridors as the highways. Norfolk Southern Railway main lines flank both sides of the reservoir. The rail line on the west side of the reservoir runs through the towns of Spring City and Soddy-Daisy and crosses the Tennessee River just below the dam into Chattanooga. On the east side of the reservoir, a main line of the Norfolk Southern Railway runs from Chattanooga, through Calhoun, and northeast to Knoxville.

At present the only bridges across Chickamauga Reservoir are at the dams on either end and at TRM 498.9 (old Blythe Ferry site). A new bridge is under construction at TRM 517.8 (Washington Ferry). Interstate 75, U.S. 11, and SR 58 cross the Hiwassee. Industrial development in the reservoir area is concentrated in the Charleston-Calhoun area where Bowater Incorporated Southern Division Paper Company and several related industries are located. There are two nuclear power plants on Chickamauga Reservoir. Sequoyah Nuclear Plant is located 13 miles upstream from Chickamauga Dam and the Watts Bar Nuclear Plant is located in the extreme upper reach of

Figure 11

Chickamauga Reservoir Area

Chickamauga near Watts Bar Dam. Adjoining the Watts Bar Nuclear Plant is TVA's inactive Watts Bar Fossil Plant. There are several wildlife refuges and wildlife management areas on Chickamauga occupying several miles of shorelines.

The Tennessee American Water Company supplies water to the city of Chattanooga. Its water intake is located in the Tennessee River at mile 465.3L.

### 3.4.2 Project Area

The immediate vicinity (one-mile radius) of Chickamauga Lock and Dam is located within a developing part of the Chattanooga urban area and is characterized by mixed uses. The core of the proposed project construction area consists of TVA-owned dam reservation land. A major traffic artery, SR 153, crosses the dam and serves to connect Interstate 75 and SR 58 on the south with U.S. Route 27 on the north.

A main line of Norfolk Southern Railway crosses immediately downstream of the lock and dam. The intersection of SR 153 and the reservoir divides the construction area into quadrants (represented by diagram in Figure 12), which may be described as follows. Moving clockwise the northeast quadrant consists of TVA dam reservation property, the intersection of Lake Resort Drive and Access Road, a residential condominium development overlooking the upstream lock approach, and commercial marinas. The southeast quadrant, or upstream left bank, is dominated by a public recreation area on the TVA dam reservation and a commercial marina. Chattanooga State Technical Community College, a waterfront recreation area, and some small industries are located on the southwest or left bank downstream. North Chickamauga Creek flows into the northwest quadrant of the affected area which is primarily forest and open space owned by TVA and the Dupont De Nemours Company.

## 3.5 Water Quality

Recent monitoring on Chickamauga Reservoir (1990-1994) has identified generally very good water quality. Overall, the “health” of the aquatic resources in Chickamauga

Figure 12

Project Area Land Use

Reservoir was better than most of the other Tennessee River mainstem reservoirs (Dycus and Meinert, 1994). Chickamauga Reservoir has an average annual hydraulic retention time of about ten days, is generally well mixed, and lacks any substantial thermal or dissolved oxygen stratification (Dycus and Meinert, 1994). Deep water dissolved oxygen levels in the downstream (forebay) region of the reservoir occasionally fall below 2.0 mg/L during low flow periods in the summer, but these conditions do not persist for very long.

Secchi depth data (a measure of turbidity and suspended solids) indicate that the light transparency of Chickamauga Reservoir is in the midrange compared with other data for Tennessee River mainstem reservoirs. This light level helps support an active algal community with summertime chlorophyll-a concentrations averaging about 7-9 micrograms per liter (Dycus and Meinert, 1994). Chickamauga waters are soft to moderately hard. The mean pH values calculated at each sampling station are in the neutral range (7.2 to 7.8).

The sediment quality of Chickamauga Reservoir, including the Hiwassee River arm, is generally good. Based on data from samples collected to investigate the potential impacts of a new lock at Chickamauga Dam, no polychlorinated biphenyls (PCB) were detected in the sediment, and the metals detected were within the range observed in sediment collected from the mainstem of the Tennessee River. Chemical analyses of the sediments indicated no organic constituent concentration of concern (Dycus and Meinert, 1994).

No radioactivity (including strontium 90) was detected in the surface water samples collected from the Chickamauga impoundment area. Radioactivity levels measured in sediment from Chickamauga Reservoir (Maxwell, 1992) are at expected background levels (samples collected by TVA in 1991). Sediment deposition downstream of Chickamauga Dam is negligible due to scour caused by the high velocity of water released from the dam.

## 3.6 Air Quality

The air quality in the vicinity of Chickamauga Lock and Dam is generally good. The dam is located in an area that is in attainment or unclassifiable for all national ambient air quality standards (NAAQS). The nearest nonattainment area from Chickamauga Dam is the Chattanooga nonattainment area for total suspended particulates (TSP), approximately 1.5 miles away. However, as explained below this nonattainment designation is a mere technicality.

In 1987, EPA revised the NAAQS for particulate matter (PM), changing the indicator for the PM standard from TSP to PM10. The PM10 indicator is based on particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers. The Chattanooga area (as well as the rest of the Tennessee Valley) has been designated unclassifiable for the PM10 NAAQS, but EPA has not yet changed the federal TSP nonattainment designation for this area. When Tennessee adopts the recently promulgated PM10 increments in its Prevention of Significant Deterioration (PSD) rules, EPA will delete the TSP nonattainment designation for Chattanooga. Consequently, TVA believes that the PM10 attainment status is the controlling consideration in evaluating the area's air quality.

## 3.7 Aquatic Resources

### 3.7.1 Chickamauga Dam Tailwater

The Chickamauga Dam tailwater (upper end of Nickajack Reservoir) extends from the dam at TRM 471.0 approximately 13 miles downstream to the vicinity of the Tennessee River gorge. The majority of flow in this tailwater comes through Chickamauga Dam; however, North Chickamauga Creek enters just downstream from the dam (TRM 469.0); South Chickamauga Creek enters at TRM 468.0; and Chattanooga Creek enters at TRM 461.0. Substrate in this river reach is predominantly bedrock, gravel, and cobble with substantial amounts of Asiatic clam (*Corbicula* sp.) shell.

Plankton communities in the tailwater are similar to those occurring upstream in Chickamauga Reservoir (Placke and Poppe, 1980; Wrenn, 1986). Little growth of plankton occurs in the tailwater because of the short retention time. Dominant species of the plankton community vary with the season and is representative of those in Chickamauga Reservoir. The zooplankton community is usually dominated by rotifers and copepods, both less abundant downstream from the dam than in the reservoir.

Most submersed macrophytes on Nickajack Reservoir occur downstream from the Tennessee River gorge (TRM 458.0) with only scattered colonies in the upstream riverine portion of the reservoir. In 1986, the peak year for aquatic vegetation on Nickajack Reservoir, about 13 acres of Eurasian watermilfoil and coontail occurred from TRM 458.0 upstream to Chickamauga Dam. However, in 1991 and 1992 no submersed aquatic macrophytes occurred in this reach of the reservoir. This absence or sparse occurrence of aquatic macrophytes in the tailwater is representative of most TVA mainstream reservoirs (Burns et al., 1992).

There is no such thing as a typical tailwater benthic macroinvertebrate (bottom-dwelling organisms) community on the impounded Tennessee River. Tailwater benthic communities vary not only from dam to dam but also from year to year within a particular tailwater (Jenkinson, 1991; Masters, 1992). In 1992, 20 varieties of benthic macroinvertebrates were found in the Chickamauga Dam tailwater. The average density was 903 animals per square meter ($m^2$). This community was dominated by Asiatic clams (61 percent) followed in abundance by flatworms (14 percent), insects (12 percent), aquatic worms (7 percent), crustaceans (5 percent), and snails (2 percent) (Masters, 1992). Zebra mussels have been found in both Nickajack and Chickamauga Locks (in 1992 and 1993, respectively), and more recently in plankton samples in the upper Tennessee River.

Results from a 1990 TVA mussel survey (Jenkinson, 1993) indicate that 18 mussel species are present in the Chickamauga Dam tailwater. This number of species is comparable to other tailwater areas on the upper Tennessee River but considerably less than the Pickwick or Kentucky Dam tailwaters (Gooch et al., 1979) or what was present in the Chickamauga Dam tailwater area prior to impoundment (Ortmann, 1925). Many mussel species are found only where the original gravel or rubble substrate has not been extensively disturbed. In these undisturbed areas, the most abundant species is the elephantear (*Elliptio crassidens*) followed by the pink heelsplitter (*Potamilus alatus*). Together, these two species account for approximately 80 percent of the mussel community found. Neither of these species is particularly valuable to the commercial mussel industry, and there is no known commercial mussel harvest in this reach of the Tennessee River. The Tennessee Wildlife Resources Agency (TWRA) has designated the four-mile reach between Marine Way Upper Light (TRM 465.9) and Chickamauga Dam as a state mollusk sanctuary.

### *Resident Fish Community*

The quality of the existing fish community in Chickamauga tailwater was measured using the reservoir fish assemblage index (RFAI), an environmental indicator, from 1990-1993 (Dycus and Meinert, 1994). The Chickamauga tailwater fish community has consistently ranked as one of the best Tennessee River mainstream tailwater fish communities. A total of 42 fish species have been collected from the tailwater during this period. Of these, bluegill, yellow bass, gizzard shad, redear sunfish, brook silversides, channel catfish, spotted and largemouth bass have been most abundant in electrofishing and experimental gill netting samples. Analysis of health of largemouth bass during 1990-1992 using the fish health assessment index (FHAI) revealed Chickamauga tailwater supported generally healthier largemouth bass than other Tennessee River mainstream tailwaters during that period (Brown et al., 1993).

### *Fish Spawning*

A variety of fish species potentially spawn in the Chickamauga tailwater. Paddlefish, spotted suckers, sauger, white bass, redhorse and buffalo species, and skipjack herring all make annual spawning migrations and concentrate immediately downstream from the dam. Some of these species will successfully spawn in the tailwater area.

However, extensive scouring of the bottom due to the extreme velocities created by dam discharges prevents use of the area immediately downstream of the dam by species needing gravel to successfully spawn.

White bass reportedly spawn over gravel substrate near Williams Island, 15 river miles below Chickamauga Dam (Anders Myhr, TWRA, personal communication). Gizzard and threadfin shad, important forage species, have been observed spawning along rip-rapped shorelines immediately downstream of the dam.

While sauger spawning locations have been documented in upper Chickamauga (Hickman et al., 1989) and Watts Bar (St. John, 1990) Reservoirs, no specific studies to identify spawning locations have been done below Chickamauga Dam. Gravel shoal areas along Williams Island are the most likely sauger spawning site. Scott and Hevel (1993) found that some sauger do migrate through Chickamauga Dam, and that configuration of the lock discharge structure plays an important role in the ability of migrating fish to successfully pass through a dam. It is possible spawning areas in Chickamauga and Watts Bar Reservoirs may be important to the maintenance of the Nickajack sauger population.

### *Sport Fishing*

Information on sport fishing in the tailwater was obtained from 1990-1993 TWRA creel survey results for all of Nickajack Reservoir (O'Bara 1990; 1991; 1992; 1993). Estimated hours spent fishing Nickajack ranged from a high of 264,000 hours (25.5 hours per acre) in 1991 declining to a low of 165,000 hours (16 hours per acre) in 1993. The statewide average for this period was approximately 20 hours per reservoir acre. Main groups fished for in Nickajack include black bass, catfish, and sunfish with largemouth bass, bluegill, channel and blue catfish making up a majority of the total catch over the four year period.

### *Commercial Fishing*

The TWRA also collected information concerning commercial fishing harvest from state waters from 1989-1993 (Todd, 1989; 1990; 1991; 1992; 1993; 1994). Total annual harvest of commercial fish from Nickajack Reservoir in 1993 was 150,000 pounds (3.18 percent of the statewide harvest). Major species harvested included channel catfish (55,000 pounds), freshwater drum (37,000 pounds), buffalo and carp (22,000 pounds each), and blue catfish (19,000 pounds).

### *Fish Flesh Contamination*

The Tennessee Department of Health has issued a precautionary advisory for Nickajack Reservoir suggesting limits on eating catfish from Nickajack Reservoir because of higher than desirable levels of PCBs (Hall and Dycus, 1991). Sources of this contamination have not been identified. Sediment sampling in the Chickamauga Reservoir did not reveal any PCBs.

### 3.7.2 Chickamauga Reservoir

The impounded portion of Chickamauga Reservoir extends approximately 45 miles from Chickamauga Dam (TRM 471.0) upstream to near Washington Ferry (TRM 515.0). The majority of flow into Chickamauga Reservoir comes through Watts Bar Dam; however, substantial flow also enters from the Hiwassee River at TRM 500.0. Other inflows include Wolftever Creek (TRM 479.0), Sale Creek (TRM 495.0), and Richland Creek (TRM 504.0).

A 1992 study indicates that the plankton community of Chickamauga Reservoir is typical of mainstem Tennessee River reservoirs. Blue-green algae dominate the phytoplankton community from April to September (57 percent). Other phytoplankton groups present include green algae (20 percent), diatoms (18 percent), cryptophytes (5 percent), euglenophytes (0.7 percent), and dinoflagellates (0.2 percent). There is a general increase in phytoplankton abundance as the summer progresses (Baker, 1993).

In Chickamauga Reservoir aquatic macrophytes are found primarily in shallow water habitats along the shorelines of embayments, over banks, and around islands. Aquatic vegetation in this reservoir has decreased in recent years from a peak of 7455 acres in 1988 to about 380 acres in 1992. In 1992 about 59 percent of the aquatic vegetation on Chickamauga Reservoir occurred upstream of TRM 502.0, and about 39 percent occurred in Soddy, Possum, and Sale Creek embayments. Eurasian watermilfoil and spinyleaf naiad are the dominant submersed macrophytes on Chickamauga Reservoir (Burns et al., 1992).

Benthic macroinvertebrate communities in reservoirs, like tailwaters, vary from reservoir to reservoir and from year to year (Jenkinson, 1991; Masters, 1992). In 1992, 11 taxa of macroinvertebrates were found not far upstream from Chickamauga Dam (TRM 472.3) at a density of 1500 organisms per square meter ($m^2$). Eleven varieties were also found in the midreservoir section (TRM 490.5) at a density of $2187/m^2$. Insects, Asiatic clams, and aquatic worms were found in this order of abundance at both locations (Masters, 1992).

Freshwater mussel resources in the impounded part of Chickamauga Reservoir have been studied very little, in part because slow-current, silt-substrate habitats typically are not colonized by many mussel species. Recent TVA bottom sampling for benthic animals in this reservoir has not encountered any native mussel species (Meinert et al., 1993). However, recent investigations have indicated that a few mussels still persist at some locations. Tennessee Wildlife Resources Agency staff examined sites in the corridor to be affected by a new highway bridge over the Tennessee River just downstream from the mouth of the Hiwassee River and found live specimens of six relatively widespread mussel species. These species were represented by relatively few individuals in this corridor and most of the mussels were old (Richard Kirk, TWRA, personal communication).

### *Resident Fish Community*

RFAI measurements in the Chickamauga Reservoir forebay region, area with three river miles upstream of Chickamauga Dam, revealed a “fair” or average (moderately impacted) fish community compared to other Tennessee River mainstream forebay regions (Dycus and Meinert, 1994). Electrofishing and experimental gill net sampling from 1990-1993 resulted in the collection of 39 fish species from the forebay. Abundant species included emerald shiners, bluegill, gizzard shad, brook silversides, spotted and largemouth bass, and redear sunfish. Analysis of largemouth bass health during 1992 using FHAI revealed the Chickamauga forebay supported largemouth bass in “fair” or average health compared with other Tennessee River forebay regions (Brown et al., 1993).

### *Sport Fishing*

Sport fishing creel information collected by TWRA from 1990-1993 indicates that anglers spent a high of 1.5 million hours (43.7 hours per acre) fishing Chickamauga Reservoir in 1991 (O’Bara 1990, 1991, 1992, 1993). The statewide average for this period was approximately 20 hours per reservoir acre. Chickamauga accounted for the third and second highest estimated hours fished of Tennessee reservoirs in 1991 and 1992, respectively. Largemouth bass, white bass, white crappie, blue catfish, and channel catfish made up a majority of the total catch over the four year period.

### *Commercial Fishing*

The TWRA also collected information concerning commercial fishing harvest from state reservoirs from 1989-1993 (Todd, 1989; 1990; 1991; 1992; 1993; 1994). Total annual harvest of commercial fish from Chickamauga Reservoir in 1993 was 402,800 pounds (8.53 percent of the statewide harvest). Major species harvested included freshwater drum (170,000 pounds), carp (91,000 pounds), buffalo (57,000 pounds), channel catfish (47,000 pounds), and blue catfish (40,000 pounds).

### *Fish flesh Contamination*

There are no fish flesh consumption advisories in effect for Chickamauga Reservoir.

## 3.8 Wetlands and Wetland Wildlife

U.S. Fish and Wildlife Service National Wetlands Inventory (NWI) maps were used to make a preliminary determination of the occurrence of wetlands. The *Soil Survey of Hamilton County, Tennessee* (Jackson, 1982), revealed that no hydric soils occur at any of the four sites identified in Figure 13 for possible placement of excavated materials from the construction site.

On the Dupont property site, upland forested areas occur south of the Norfolk Southern Railway spur. A mowed power line right-of-way parallels the river separating sawtimber sized hardwoods from the somewhat younger wooded riparian zone. No wetlands occur on this site. Also, site inspection confirmed that no wetlands occur along the shore between TRM 470.1 right bank (R) and 470.8R. This riparian zone, however, contains vegetation more adapted to survival and reproduction nearer permanent water. Essentially, along a subtle moisture gradient, a subset of those plants identified in the Upland Vegetation and Wildlife Section (Section 3.9), occur here. Dominant shoreline tree species include elm, silver maple, green ash, hackberry (sugarberry) and box elder. Much of the understory is dominated by privet and honeysuckle. River cane is dominant at some locations, along with poison ivy and grapes. Wetland/riparian wildlife expected to utilize this shoreline habitat includes several amphibians, reptiles, songbirds, and small mammal species. Additionally, transient raptors and resident/transient wading birds occasionally utilize this site, primarily as resting/perching habitat.

Page for Figure 13

At approximately TRM 468.8L (left bank looking downstream from the dam), a wetland was identified and verified through field evaluation in July 1990 (Stan Davis, TVA, personal communication). Using the system developed by Cowardin et al. (1979), this wetland can be classified as: System - Palustrine; Class - Forested Wetland; Subclass - Broad-leaved Deciduous; Water Regime Modifier - Temporarily Flooded. This wetland is approximately 200 feet wide and extends along the shoreline from TRMs 468.8L to 469.4L. The list of wetlands wildlife species expected to utilize shoreline habitats in the vicinity of TRM 468.8L includes numerous reptiles, amphibians, songbirds, and small mammals. Additionally, transient raptors, resident/transient wading birds, wood ducks, and migrant-wintering waterfowl would also be expected to use this area.

### 3.9 Upland Vegetation and Wildlife

The Chickamauga Dam site occurs in the Ridge and Valley physiographic province as defined by Fenneman (1938). Botanically, this site is located within the Oak-Pine Forest Region described by Braun (1950). This region is considered a transition zone in which the evergreen forests of the South mingle with the hardwood forests of the nation's interior. The most representative forested communities in this region occur on relatively undisturbed upland sites. On such sites short-leaf, loblolly, and Virginia pines share dominance with several species of oak including southern red, post, black, white, and blackjack oak.

The three major vegetative communities found on the Chickamauga Lock construction area and TVA dredge material disposal site (Figure 13) are mowed lawns, loblolly pine plantations, and shrub or brush areas. Lawn areas have several grass species, as well as herbaceous species tolerant of repeated mowing. Typical herbs for these areas include dandelion, buttonweed, plantain, and self-heal. Most of the forested portion of the site is a loblolly pine plantation with hardwood species in the understory. The principal hardwood species include hackberry, slippery elm, winged elm, dogwood, and redbud. Privet and poison ivy are dominants in the shrub layers. The shrub areas occur on sites previously cleared of vegetation. These sites are reverting to thickets of various hardwood saplings, privet, elderberry, and honeysuckle.

The mowed lawns have little wildlife value other than as foraging habitat for resident Canada geese, killdeer, American robins, European starlings, and a few other species. A small brushy area on the site provides habitat for species such as eastern cottontails, white-eyed vireos, northern cardinals, and field sparrows. A power line bisects the loblolly pine plantation. Wildlife species present in this habitat include the eastern chipmunk, gray squirrel, mourning dove, red-bellied woodpecker, American crow, blue jay, Carolina chickadee, tufted titmouse, Carolina wren, blue-gray gnatcatcher, American robin, red-eyed vireo, pine warbler, Kentucky warbler, summer tanager, northern cardinal, rufous-sided towhee, common grackle, and box turtle. Additional species present during the winter include golden-crowned kinglet and white-throated sparrow. Because this tract adjoins a large contiguous forest tract, the Big Ridge Habitat Protection Area, the number of bird species present is probably higher than it would be in an isolated pine stand.

The Dupont property area (Figure 6) contains loblolly pine plantations, deciduous woodlots, and grassy and brushy power line rights-of-way, bisected by a railroad. The pine plantations have a hardwood understory of hackberry, slippery elm, dogwood, and redbud. The deciduous woodlots contain several species of oaks including southern red oak, scarlet oak, northern red oak, chestnut oak, black oak, hackberry, black cherry, sweetgum, silver maple, sycamore, elm, hickories, black locust, mulberry, white ash, box elder, and dogwood. This understory contains sumac, privet, and wild grapes. Shrub areas on this site contain several species of hardwood saplings, privet, and Japanese honeysuckle. The mowed power line right-of-way parallels the river separating the sawtimber sized hardwoods from the somewhat younger wooded riparian zone.

Wildlife species present in this area include white-tailed deer, eastern gray squirrel, gray fox, eastern chipmunk, Virginia opossum, raccoon, woodchuck, eastern cottontail, American kestrels, red-tailed hawk, bobwhite quail, mourning dove, northern flicker, eastern wood-pewee, blue jay, Carolina chickadee, tufted titmouse, Carolina wren, eastern bluebird, white-eyed vireo, common yellowthroat, northern cardinal, indigo bunting, rufous-sided towhee, field sparrow, and common grackle. Because of the small size and linear shape of the forested areas, species requiring large forested areas are generally absent.

Lakeward of the Dupont site, the stretch of shoreline proposed to be affected lies on the right descending bank downstream of the Norfolk Southern Railway bridge from approximate TRM 470.1 to 470.8. The dominant trees of this riparian zone are sugar maple, hackberry (sugarberry), green ash, elm, box elder, and black locust. Occurring, but less abundant, are silver maple, black walnut, tulip tree, hickory, black cherry, and osage orange. Poison ivy and invasive exotics such as Chinese privet and Japanese honeysuckle are the dominants in the dense understory. Other understory species include redbud, river cane, blackberry, crossvine, wild grape, and multiflora rose.

## 3.10 Threatened and Endangered Species

### 3.10.1 Aquatic Species

A number of aquatic species which once occurred in the Chickamauga Dam tailwater are now on the U.S. Fish and Wildlife Service lists of endangered or threatened wildlife, or are candidates for these lists. These species are listed in Table 18. This table also includes an indication of whether each of these species still occurs in the tailwater downstream from Chickamauga Dam, in Chickamauga Reservoir, or in the lower Hiwassee River. The recent occurrence determinations are based on the results of surveys made by federal and state agencies and incidental collections made by sport and commercial fishermen.

***Chickamauga Tailwater***

While Table 18 includes the names of 19 listed or candidate species, available information indicates that just three of these species are known to persist in the Chickamauga Dam tailwater. The single mollusk on this short list, the pink mucket (*Lampsillis orbiculata*), was found at four sites between TRMs 468.6 and 470.1 during a

## Table 18
**Federal endangered, threatened, and candidate species known from the Tennessee River downstream from Chickamauga Dam (TRM 458-471), within Chickamauga Reservoir (TRM 471-515), or in the lower Hiwassee River (HRM 0-20).**

| Common Name | Scientific Name | Protection Status | Still Present? | | |
|---|---|---|---|---|---|
| | | | Downstream (TRM 458-471) | Chickamauga Reservoir | Lower Hiwassee |
| **SNAILS** | | | | | |
| Spiny riversnail | *Io fluvialis* | C2 | N | N | N |
| Boulder snail | *Leptoxis crassa* | C2 | N | N | N |
| Smooth rocksnail | *Leptoxis virgata* | C2 | N | N | N |
| Varicose rocksnail | *Lithasis verrucosa* | C2 | N? | N | N |
| Anthony's riversnail | *Athearnia anthonyi* | LE | N? | N | N? |
| **Mussels** | | | | | |
| Spectaclecase | *Cumberlandia monodonta* | C2 | N | N | N |
| Fanshell | *Cyprogenia stegaria* | LE | N? | N | N |
| Dromedary pearlymussel | *Dromus dromas* | LE | N? | N | N |
| Tuberculed blossom | *Epioblasma t. torulosa* | LE | N | N | N |
| Cracking pearlymussel | *Hemistena lata* | LE | N | N | N |
| Pink mucket | *Lampsillis orbiculata* | LE | Y | N | N |
| Ring pink | *Obovaria retusa* | LE | N | N | N |
| White wartyback | *Plethobasus cicatricosus* | LE | N | N | N |
| Orange-footed pearlymussel | *Plethobasus cooperianus* | LE | N? | N | N |
| Rough pigtoe | *Pleurobema plenum* | LE | N? | N | N |
| Pink pigtoe | *Pleurobema rubrum* | C2 | N? | N | N |
| **Fish** | | | | | |
| Lake sturgeon | *Acipenser fulvescens* | C2 | N | N | N |
| Paddlefish | *Polyodon spathula* | C2 | Y | Y? | Y? |
| Snail darter | *Percina tanasi* | LT | Y | N? | Y |
| **Amphibian** | | | | | |
| Eastern hellbender | *Cryptobranchus a. allegeniensis* | C2 | Y? | N? | N? |

Abbreviations:
- C2 - on U.S. Fish and Wildlife Service (USFWS) status review (candidate) list; biological information is still being collected.
- LE - listed as an endangered species by USFWS.
- LT - listed as a threatened species by USFWS.
- N - once found in this area but no longer occurs here.
- Y - still occurs in this area.
- ? - this is the likely status; however, insufficient information exists to confirm or refute this opinion.

survey conducted in 1990 (Jenkinson, 1993). Paddlefish (*Polyodon spathula*) apparently persist in sufficient numbers in this part of the river that they make up part of the commercial fishery (TWRA, unpublished data). Snail darters (*Percina tanasi*) occur in South Chickamauga Creek and are known to drift downstream into the Tennessee River. Four snail darters were seen in the river near TRM 468.2 in 1980 (Biggins and Eager, 1983).

One other species included in Table 18 (hellbender, *Cryptobranchus a. allegeniensis*) is likely to persist in the Chickamauga Dam tailwater. Habitat conditions in the tailwater appear suitable for the hellbender; however, no recent records have been found.

Similarly, there is somewhat less likelihood that seven other protected species still exist in the Chickamauga Dam tailwater. No specimens of Anthony's riversnail (*Athearnia anthonyi*) or the varicose rocksnail (*Lithasia verrucosa*) have been found in this river reach, but these species occur in similar habitats downstream from Nickajack Dam (Gooch et al., 1979; Jenkinson, 1994). A few specimens of each of five mussel species (fanshell, *Cyprogenia stegaria*; dromedary, *Dromus dromas;* orange-footed, *Plethobasus cooperianus*; rough pigtoe, *Pleurobema plenum;* and pink pigtoe, *Pleurobema rubrum*) have been found in the Watts Bar tailwater (Gooch et al., 1979; Ahlstedt, 1989) but none of these species has yet been found in similar habitats below Chickamauga Dam.

### *Chickamauga Reservoir*

Information presented in Table 18 indicates that no endangered, threatened, or candidate listed species are known to persist in the body of Chickamauga Reservoir. While as many as 19 now-listed or candidate species occurred in this reach of the Tennessee River prior to impoundment, there are no recent records for these species from the impounded portion of the reservoir. Suitable habitat for most of these species no longer occurs in this area, and they are quite unlikely to be found here.

The three possible exceptions to this generality are the paddlefish (*Polyodon spathula*), snail darter (*Percina tanasi*), and hellbender (*Cryptobranchus a. allegeniensis*). Parts of the impoundment should be suitable paddlefish habitat, and some individuals are likely to occur; however, no recent records have been reported. Snail darters and hellbenders might drift into the more riverine sections of the impoundment; however, these areas would be marginal habitats for both species, and only transient individuals are likely to be present.

### 3.10.2 Terrestrial Threatened and Endangered Species

No populations of federal or state listed plant species or plant species candidates under review for federal or state listing are known to exist on the sites proposed for disturbance. Mountain skullcap (*Scutellaria montana*), a federally endangered member of the mint family, occupies areas of suitable habitat on the Big Ridge Habitat Protection Area located immediately adjacent to the TVA site designated for disposal of excavated material generated by lock construction (Figure 6). This herb requires shade provided by an intact forest canopy and is especially sensitive to encroachment from weed species when the forest canopy is removed. Individuals of this species are known to occur within 150 feet of the proposed spoil disposal site.

Terrestrial animals listed as federally endangered or threatened, or considered as candidate species for such listing, that have been reported from Hamilton County and the surrounding area include the bald eagle, peregrine falcon, and Tennessee cave salamander. A discussion of the status of each of these species in the project area follows.

Bald Eagle (*Haliaeetus leucocephalus*)--This species, currently listed as federally threatened, winters in the project area and is occasionally present during summer months. Bald eagles do not nest in the project area, although TWRA attempted to establish a nesting population about 30 miles upstream of Chickamauga Dam. During recent winters, about ten to 12 eagles have been present on Chickamauga Reservoir, and one or two on Nickajack Reservoir.

Peregrine Falcon (*Falco peregrinus*)--This federally endangered species is an uncommon migrant through the area and a rare winter resident. It formerly nested on Walden Ridge about six miles north-northwest of Chickamauga Dam. Peregrine falcons do not regularly use any areas in the immediate vicinity of Chickamauga Dam.

Tennessee Cave Salamander (*Gyrinophilus palleucus*)--This cave-dwelling, aquatic salamander is a Category 2 candidate for federal listing. It has been reported from caves on Lookout Mountain, about nine miles southwest of Chickamauga Dam. No caves or other suitable habitat are known in the immediate vicinity of this dam.

State-listed terrestrial species in the area include the red-shouldered hawk (*Buteo lineatus*), common barn-owl (*Tyto alba*), and green salamander (*Aneides aeneus*), all listed as in need of management in Tennessee. The hawk and owl have been reported from the vicinity of Amnicola Marsh, about 2.5 miles southwest of Chickamauga Dam. Suitable foraging habitat (grassland and brushy fields) for barn-owls occurs on the Dupont site identified for temporary storage of excavated materials. Suitable forest habitat for the hawk occurs on the Big Ridge tract. The green salamander, which was formerly a candidate species for federal listing, utilizes sandstone cliff face habitats on Lookout and Signal Mountains. No habitat suitable for this species occurs in the immediate vicinity of the project.

### 3.11 Archaeological, Historical, and Cultural Resources

Within the Chickamauga Dam region, archaeological sites have been documented from the Paleo (ca. 10,000 - 7500 BC), Archaic (ca. 7500 - 1000 BC), Woodland (ca. AD 900 - 1000), and Mississippian (ca. AD 900 - 1540) time periods.

During Proto-historic time, this region was occupied by the Cherokee Indians; White settlement began in the first quarter of the nineteenth century. An archaeological survey in 1992 (Fryman and Holland, 1992) determined that project impact areas likely to be impacted by new lock construction were void of intact archaeological deposits. If other areas are ultimately used, then additional archaeological evaluation and possible field testing will be required once actual impacts and boundaries are determined. An additional archaeological survey in 1994 (Alexander, 1994) of an area proposed for right bank removal between TRM 470.1 and 470.8 resulted in the delineation of two archaeological sites, 40HA397 within the first terrace and 40HA398 within the second terrace. Neither site was determined eligible for the National Register of Historic Places.

The only historic structure, within or adjacent to the project site, which will be impacted by new lock construction is the current Chickamauga Dam complex. This complex has been determined eligible for the National Register of Historic Places.

### 3.12 Noise

The area around the lock can be generally described as urban with most of the noise coming from traffic crossing the SR 153 overpass. The closest receptor is a multiresident housing complex located near the river's edge approximately one-half mile upstream from the lock. Existing Day-Night Average Sound level ($L_{dn}$) for general urban areas is estimated to be in the range of 55-65 decibels (National Academy of Sciences, 1977). Traffic volume (highway noise) on the overpass may increase these values.

### 3.13 Flood Control/Floodplains

The 100-year floodplain for the Tennessee River varies from elevation 658.5 at mile 466.8 to elevation 686.0 immediately upstream of Chickamauga Dam. The TVA Flood Risk Profile elevations on the Tennessee River vary from elevation 665.0 at mile 466.8 to elevation 689.0 immediately upstream of Chickamauga Dam. The TVA Flood Risk Profile is used to control flood damageable development on TVA lands. For North Chickamauga Creek the 100-year floodplain is the area lying below elevation 659.9, and the 500-year floodplain is the area lying below elevation 666.3.

Chattanooga, Tennessee, has adopted the 100-year flood as the basis for its floodplain regulations, and any development will be consistent with these regulations. For this project area, the floodways adopted by the city of Chattanooga are those portions of the Tennessee River and North Chickamauga Creek channels and floodplains that must remain open and unobstructed to allow passage of floodwaters in order to prevent any substantial increase in upstream flood elevations.

The area impacted by the construction of the Chickamauga Lock extends from Tennessee River mile 466.8 (the Colwell Bend Channel Modification area) to mile 471.0 (Chickamauga Dam). North Chickamauga Creek will also be impacted between creek mile 0.2 and 0.4.

Chickamauga Dam is one of the nine Tennessee River dams that make up the TVA reservoir system. It is a multipurpose dam, providing navigation, flood control and power generation benefits as well as numerous secondary objectives. The dam is 129 feet high and has a spillway width of 894 feet. The spillway has 18 individual spillway bays, each with a 40 foot wide lift gate.

## 4.0 Environmental Consequences

This section describes the potential impacts on the environmental resources of the project area from the no action alternative and the alternative of constructing a 60 x 360 foot lock, or a 75 x 400 foot lock, or a 110 x 600 foot lock. The effects on each resource are subdivided into impacts associated with the construction and operational phases of each alternative.

### 4.1 Socioeconomic

#### 4.1.1 Construct New Lock

In the alternative, a new lock (110 X 600, 60 X 360, or 75 X 400) would be constructed at Chickamauga Dam adjacent to the existing lock that would be taken out of service and plugged with concrete. Economic and social impacts would occur in the general area of the project during construction and in the upper Tennessee River region during operation of the facility. Similar socioeconomic impacts would apply to all three lock sizes, including employment and income changes.

4.1.1.1 Construction Phase

The proposed Chickamauga Lock project would generate an average of 467 new jobs and $16.7 million in new income annually in the Hamilton County area during its five-year construction period.[14]

### *Direct Project Benefits*

Within the impact area, the Chickamauga project should generate an average of 267 construction jobs and $9.8 million a year over the five-year project duration. Forty-two percent of these jobs (approximately 112) will be filled by skilled labor while 22 percent (approximately 59) will be unskilled jobs. The remaining 36 percent (approximately 96) represents managerial, contractor, and other such positions.

To determine how these jobs are likely to be distributed among the impact area counties, the TVA Sequoyah Plant survey reports, which provide a breakdown of the number of workers by county of residence, were utilized. The 267 construction jobs that the Chickamauga project is expected to generate were allocated to the impact area counties according to the distribution of construction workers derived from the surveys.[15] The proportions are shown in Table 19 below.

[14]The income figure is in terms of 1995 dollars as are other dollar numbers in this report unless otherwise noted.

[15]The distribution of construction workers was computed in the following manner. Using the residence breakdown from the surveys, counties that were identified as construction worker residences in both surveys were included in the impact area. The sum of the number of Sequoyah workers resident in a particular impact area county for each survey year, 1978 and 1982, was calculated. This number was then divided by the sum of the Sequoyah workers resident in the total impact area in 1978 and 1982 to determine the percent distribution for that county.

Table 19
Allocation of Direct Jobs by County

| County | Proportion of Jobs | Allocated Direct Jobs |
|---|---|---|
| Georgia: | | |
| Catoosa | 1.5% | 4 |
| Walker | 3.5% | 9 |
| | | |
| Tennessee: | | |
| Bradley | 2.0% | 5 |
| Grundy | 1.0% | 3 |
| Hamilton | 83.0% | 222 |
| Marion | 3.4% | 9 |
| Rhea | 3.8% | 10 |
| Sequatchie | 1.8% | 5 |
| | | |
| Total | 100.0% | 267 |

Construction earnings were also allocated throughout the impact area in a similar manner.

### *Indirect Project Benefits*

TVA maintains several econometric models to produce forecasts and perform impact analyses for the Valley. The Chattanooga subregional model was used for this study to determine the employment and income multipliers associated with the project.[16] Using the multiplier of 1.75 established by the model and the 267 estimated direct jobs related to construction, a total of 467 direct and indirect jobs are expected to be generated by the lock construction project. The 200 indirect jobs would be created in mainly the commercial sector.

[16] Multiplier effects result when new jobs are created in an area that result in increased demand for local goods and services. As consumption increases, more workers are needed to service the growing demand, giving rise to the creation of additional employment in an area. In turn, these indirectly created jobs and the income generated from them further enhance local spending and employee demand, thus generating yet another round of employment and income increases.

The proportions presented in Table 19, and the employment multiplier above were used to allocate these indirectly generated jobs within the project area counties.[17] This allocation is presented in Table 20.

Hamilton County will have the bulk of new jobs directly and indirectly generated as a result of the project construction.

The income directly resulting from the project will have multiplied indirect benefits distributed throughout the project area similar to the employment effects. According to figures generated by TVA's subregional econometric model, the project's income multiplier should be approximately 1.7, which indicates that each directly generated dollar will create an additional 70 cents in income elsewhere in the local economy. TVA estimates show that direct earnings resulting from the project would add, on average, $9.8 million during any given year of the project's five-year duration to the local economy. After this new income is distributed throughout the project area via local purchases, an additional $6.87 million in earnings should be generated indirectly on average for any given project year. Together, the direct and indirect income effects of the project should be approximately $16.7 million per year, with the bulk of the benefits going to Hamilton County which has a much more developed commercial sector than the remainder of the project area.

---

[17]Due to the rural nature of many of these counties, use of the overall Chattanooga subregional multiplier may overestimate the potential for indirect job creation in parts of the impact area (e.g., Rhea County) and underestimate it in others (e.g., Hamilton County). Because the project's indirect employment potential is relatively small, however, the difference in results via the use of more targeted multipliers versus those of the overall multiplier is minor.

Table 20
Allocation of Indirect Jobs by County

| County | Proportion of Jobs | Allocated Indirect Jobs |
|---|---|---|
| Georgia: | | |
| Catoosa | 1.5% | 3 |
| Walker | 3.5% | 7 |
| Tennessee: | | |
| Bradley | 2.0% | 4 |
| Grundy | 1.0% | 2 |
| Hamilton | 83.0% | 166 |
| Marion | 3.4% | 7 |
| Rhea | 3.8% | 8 |
| Sequatchie | 1.8% | 4 |
| Total | 100.0% | 201 |

An additional indirect benefit of this project would be the unemployment compensation savings that would be gained if this project's potential workers are currently unemployed. According to the Tennessee Office of Employment Security in Knoxville, workers who lose their jobs become eligible for 26 weeks of unemployment compensation which has a maximum weekly payment of $170. If it is assumed that each of the 467 labor force members expected to be directly or indirectly employed as a result of the project were instead collecting unemployment compensation for 26 weeks of one year of the project and that each would be eligible for the maximum benefit level of $170, then the unemployment compensation pool would be required to pay out an additional $2.1 million to these people.[18] This possible $2.1 million saved by employing these workers as a result of the project could be considered an indirect benefit.

[18]Benefits from other welfare programs (e.g., AFDC, Food Stamps) that might no longer be received upon employment would represent additional indirect savings associated with the project. These benefits are not considered here.

### *Construction Impacts Summary - Socioeconomics*

The proposed Chickamauga Lock project could generate 467 new jobs and $16.7 million in new income annually in the Hamilton County area over its five-year construction period. Of the 467 jobs, 267 would be directly created while 200 mostly commercial sector positions would be indirectly created. The $9.8 million in directly generated income would also amount to an additional $6.87 million in indirect monetary gain. While the bulk of these employment and income benefits would accrue to Hamilton County, the project would also have a positive impact on the seven other counties identified in the project area.

#### 4.1.1.2 Operational Phase

If a new lock were constructed at Chickamauga Dam, TVA and USACE survey data indicate that barge traffic on the Tennessee River would increase from 2.1 to 10.6 million tons in the year 2000 in an unconstrained system. The 8.5 million tons difference between the 2.1 and 10.6 million tons is primarily from potential traffic that would be attracted to barge transportation from other transportation modes.

Indirect impacts of building a new lock at Chickamauga include the shifting of a considerable amount of tonnage presently moving via overland routes to the safe and more fuel-efficient barge mode. Transportation survey and cost data suggest that upstream forest products moving to pulp and paper plants could shift from overland routes to some combination of overland-barge routes. Transportation data suggest that the magnitude of forest products harvesting for use in the pulp mills would not increase relative to new lock construction but, rather, the transportation mode for movement of the chips to the plants would simply shift. Transportation data also demonstrate that wood chips would not be harvested on the upper Tennessee River for shipment to export ports given the distance, low value of the product, and the relatively low density of wood chip cargo that results in relatively small loads per barge. First, the upper Tennessee River area is a remote location from Mobile when compared to the lower Tennessee River or Tennessee-Tombigbee Waterway. Second, wood chips are a low value commodity, and transportation cost is thus a large component of total delivered cost. Third, wood chips are fairly light weight and cannot be tightly packed in an open hopper barge. Whereas some commodities can be loaded to 1500 tons in a single barge, wood chips are loaded to about 1250 tons. The transportation cost for an eight barge tow to Mobile from Knoxville would be over $200,000 ($20 X 1250 X 8) as compared to transportation rates on the Tennessee-Tombigbee Waterway which would be approximately one half the upper Tennessee transportation rate.

No additional adverse environmental effects would be expected to occur from underground mining operations in eastern Kentucky. Low-sulfur coal, which comes from deep mines in eastern Kentucky, is regulated by the rules and policies established and enforced by the U.S. Department of the Interior, Office of Mine, Health, and Safety, and the U.S. Office of Surface Mining. The present mining regulations applicable for underground operations should be adequate to meet any potential environmental impacts. Surface coal in this area has essentially been depleted and thus strip mining impacts are not a factor regarding potential Chickamauga Lock traffic. Also, the current environmental costs associated with surface mining would prohibit any future operations.

Data presented in Table 11 (Section 3.2.1) reflect the traffic shift pattern from the current upstream situation to a dominance of downstream movements. Basically, this shift is due to the potential coal traffic that was identified in the traffic survey as originating in the Chickamauga pool. Thus, Watts Bar traffic demand is much lower than that of Chickamauga reflecting the shipment origin and direction of the potential coal movement.

The commodity mix of projected traffic demand is shown in Table 21. The commodity traffic demand forecast shows very little change in the relative distribution of commodity traffic over the projection period. The largest tonnage increases over the projection period occur in coal and coke (7.1 million), grains (1.0 million), forest products (1.3 million), ores and minerals (0.7 million), chemicals (0.4 million), and asphalt (0.4 million). Coal accounts for the large majority of commodity traffic throughout the projection period. Its share of total traffic diminishes only slightly between 2000 and 2050, from 60 to 58 percent. The change in coal traffic is generally aligned with expected growth in coal consumption by southeastern utilities.

Table 21

PROJECTED UPPER TENNESSEE RIVER TRAFFIC DEMAND
BY COMMODITY GROUP, 1989-2050
(Thousands of Tons)

| Commodity | 2000 | 2050 | Growth Rate 1989-2050 |
|---|---|---|---|
| Coal and Coke | 5,194 | 12,220 | 1.4 |
| Petroleum Fuels | 13 | 42 | 1.9 |
| Asphalt | 167 | 520 | 1.9 |
| Aggregates | 225 | 422 | 1.0 |
| Grains | 1,287 | 2,297 | 1.6 |
| Chemicals | 195 | 612 | 1.9 |
| Ores and Minerals | 710 | 1,425 | 1.1 |
| Iron and Steel | 245 | 463 | 1.0 |
| Forest Products | 580 | 1,839 | 1.9 |
| All Others | 87 | 181 | 1.2 |
| Total | 8,703 | 20,021 | 1.5 |

The above tonnage increases result primarily from intermodal transportation shifts, most of which are expected to occur shortly after construction of the new lock. The environmental impact of this shift (fuel usage, air pollution, fatalities, etc.) has been addressed in Section 4.2. Some of the tonnage increase could result from increases in production at selected industries. The impact of this production increase has not been addressed in this final EIS because any prediction of such production increases would be speculative. Further, these production increases would result from possible decisions of third parties over which TVA would have no control or responsibility. In instances where activities associated with these production increases require site-specific TVA reviews (26a permits) by virtue of the location of the activity on the river, TVA's actions would be subject to future NEPA review.

### *National Economic Development Benefits*

Upon closure of Chickamauga Lock during or near the year 2005, benefits generated from the potential traffic and benefits at the existing lock will accrue to the new lock. TVA transportation data suggest that the average savings per ton at a new Chickamauga Lock in 1995 dollars would be $6.62 per ton. When estimated over the period 2005-2050, project benefits accruing to the actual and potential traffic yield a discounted total value of $1.2 billion when evaluated at $6.62 per ton. Average annual project benefits are $100 million.

### *Operational Impacts Summary - Socioeconomics*

Secondary impacts of building a new lock at Chickamauga include the generation of considerable transportation savings to shippers and a general improvement of the business climate. Transportation costs are reduced, and barge transportation becomes more dependable. The magnitude of the NED benefits discussed above indicate that the benefits of a new lock at Chickamauga to the taxpayer could be large. For example, taxpayers could benefit from the $1.0 million reduction in the cost of shipping asphalt to Knoxville. Existing industry could also benefit from an increased savings for shipping commodities. Industrial recruitment could also be easier in upper east Tennessee. Some companies have declined to consider sites above Chattanooga due to the relatively high cost of navigating above Chickamauga Lock and also the unreliability of this lock.

### *Summary of Socioeconomic Impacts of a New Lock*

Building a 110 x 600 foot lock at Chickamauga Dam could result in the following impacts:

1. The reservoir at Chickamauga Dam could be the head of low cost navigation on the Tennessee River, and the towing rate could fall by 3.75 mills per ton per mile on this range of the river. Even though two small locks would remain between Chickamauga Dam and Knoxville, the towing rate could fall on the upper Tennessee River from 6.5 to 5.3 mills per ton per mile.

2. Over ten million tons of traffic could be accommodated at the lock during the first year of operation; and over the life of the project, an average annual benefit stream of $100 million could accrue to the project.

3. The economic climate in upper east Tennessee could improve as transportation costs would fall due to (1) economies related to a more efficient lock at Chickamauga, (2) a cheaper competitive barge alternative to overland transportation, and (3) creation of a reliable lock at Chickamauga.

4.1.2 No Action Alternative

In the no action alternative the lock at Chickamauga would be monitored until it was determined to be no longer safe. At that time it would be plugged, and upstream navigation on the Tennessee River would end at Chickamauga Dam. Industry on the Tennessee River above Chickamauga Dam (river mile 471) to the French Broad River above Knoxville (river mile 652) would be divorced from the option of barge transportation, a river distance of 181 miles. The tributaries above Chattanooga would also be divorced from interreservoir barge transportation. These are the Hiwassee river (19 miles), the Clinch River (63 miles), the Emory River (12 miles), the French Broad (3 miles), and the Little Tennessee River (19 miles). Closing the Chickamauga Lock would thus decrease the nation's navigable waterways by 297 miles.

The economic impacts of closing Chickamauga Lock would drastically affect the upper east Tennessee area. The impacts would include (1) closure of barge terminals, (2) increased production costs for area industry and government with the possible closure of some firms, (3) diversion of traffic to overland routes with increased pollution and accident rates, (4) national energy and security impacts by isolating the Oak Ridge, Tennessee, projects from barge traffic, (5) higher shipper cost due to elimination of the least cost and competitive alternative, and (6) the negative impact on riverfront development and recreational boating. Closure of Chickamauga Lock would be in effect abandoning the existing navigation facilities at Watts Bar, Ft. Loudoun, and Melton Hill Locks. Environmental impacts of intermodal traffic shifts are discussed in Section 4.2.

### *Higher Shipper Costs for Actual and Potential Barge Traffic*

If Chickamauga Lock was not available for commercial navigation, 2.1 million tons of traffic would shift from barge to overland transportation or would not be transported if the producing companies ceased operations due to higher transportation costs. This traffic is shown in Table 10 for the year 1989, the base year for estimation of the benefits of a new lock at Chickamauga Dam. These data are discussed in the USACE publication (1993) *Upper Tennessee River Navigation Improvement Study Navigation Systems Analysis* which was produced on contract for TVA.

The savings to the nation or the NED benefits of the existing lock at Chickamauga are estimated to be $11.77 per ton in 1995 dollars. Keeping the existing lock open thus contributes $24.7 million to national economic development annually or $324 million in perpetuity when evaluated at the federally mandated discount rate of 7.625 percent.

### *Summary of Socioeconomic Impacts Due to Lock Closure*

Closure of the navigation lock at Chickamauga Dam could result in the following impacts:

- The loss of 297 miles of navigable inland waterway and the public's investment in three locks above Chickamauga.

- The loss of $25.0 million per year of NED shipper savings benefits which equates to $324 million in perpetuity.

- The possible loss of over 800 jobs at ASARCO and A. E. Staley Company, and the loss of about 1600 service sector jobs through the multiplier effect.

- A payroll loss in upper east Tennessee of $75 million per year or $970 million in perpetuity.

- A general rise would be expected in regional transportation rates resulting from elimination of the competitive barge alternative.

- Separation of the Oak Ridge facility and other industry from access to barge transportation which could result in lost opportunities for industrial expansion, and at

Oak Ridge, inability to move certain national defense equipment there for maintenance and repair.

- Closure of two public terminals with a loss of 67 jobs and the abandonment of a $1.5 million investment.

### 4.2 River Traffic and Infrastructure

Improving the lock at Chickamauga, even while the locks at Watts Bar and Ft. Loudoun remain at 60 x 360 feet, appreciably improves transportation economies on the upper Tennessee River. The seven lock-throughs now required to process a tow will be reduced to one, thus saving six hours on a trip to Knoxville and simultaneously allowing tow size to increase. A large lock would allow eight barges to be locked through with a towboat at one time. Given that the cost of the towboat including barge rental on the upper Tennessee River averages about $300 per hour, improving only Chickamauga Lock would save existing shippers about $668,000 per year (6 hours x $300/hour x 371 tows) on traffic presently moving on the system. Further, improving Chickamauga Lock in isolation from the other two projects would provide shipper savings because the head of low cost navigation would be moved 58 miles further upstream and include the Hiwassee River which is navigable for an additional 19 miles. To the extent that traffic growth occurs in the Chickamauga Reservoir, the tramp towing rate that is now in effect below the lock would then extend upstream to Watts Bar Lock and Dam.

#### *Forest Products Traffic*

Potential upper Tennessee River traffic was identified based on two surveys. In a 1987 survey, 827 companies were contacted during the period June to September under the supervision of the Huntington District Navigation Support Center of the U.S. Army Corps of Engineers. Among these, 142 wood and paper product firms were contacted, including Champion Paper Company, Bowater Southern, International Paper Company, and the Georgia Pacific Corporation. In 1991, 143 companies were resurveyed including ten wood and paper companies. A potential waterway demand of 613,690 tons of potential forest tonnage was identified from the surveys given a new and larger lock at Chickamauga. A screening of these data to determine their potential diversion to barge given projected transportation rate savings, however, suggested that less than 40 barge loads of woods products (about 50,000 tons through mode shifts) would gain a transportation rate advantage sufficient to use a new lock at Chickamauga (USACE, 1993).

An econometric analysis of the historical data in combination with an economic analysis of the survey data indicated that the majority of the forest products' demand from an improved lock at Chickamauga Dam would most likely be pulp and paper plants which would use the river to shift traffic modes (away from truck and railroad services) for transportation rate savings. This could occur at either the Bowater Southern plant or the Champion International plant at Canton, North Carolina. Champion currently barges wood chips via barge from Demopolis, Alabama, to their mill at Courtland, Alabama. An extension of this movement to upper east Tennessee with a truck haul to Canton could replace an existing overland movement to the North Carolina plant. Bowater Southern currently receives wood products, chips and residue, via barge, truck and rail. An improved river system would give these companies the option of shifting more of their traffic to water transportation.

Outbound woods products traffic is presently newsprint which moves from Bowater Southern plant to markets off of the Tennessee River. Wood chips, a possible outbound commodity, has not historically moved on the upper Tennessee River nor was it identified in either the 1987 or 1991 surveys of potential forest products users. TVA processed chip mill barge terminal applications between river miles 412 and 424 on the Tennessee River (between Alabama State Docks and Nickajack Dam) which, if approved, would have made possible outbound wood chip traffic (albeit originating below Chickamauga Lock). These permits, required pursuant to Section 26a of the TVA Act, were denied by TVA in 1993. TVA reviews new applications on a case-by-case basis, but none have been received for the area upstream from Chickamauga Lock.

The likelihood that TVA will receive requests for permits above Chickamauga Dam is governed by the economics of chip mill operations which change relative to conditions below Nickajack Lock, even assuming that a new lock is constructed at Chickamauga Dam. Small locks, low commodity value, distance to markets, and low density of wood chips all combine to make movements of wood chips from upper east Tennessee to foreign or domestic markets via the Tennessee River system unlikely. Wood chips valued at about $40 per ton are loaded lightly in open hopper barges at 1250 tons per barge. When compared to the location of the proposed wood chip terminals near Nickajack Dam, shipping wood chips from the Knoxville area adds an additional 230 miles to the length of the haul to Mobile. Even with the transportation savings accruing to a new lock equaling 19 cents per ton, transportation cost equals over 30 percent of total costs when shipping from the Knoxville area. Shipment of wood chips by railroad from the Knoxville area is more economical than by barge. This is shown in Table 22. Additionally, the cost of shipping wood chips from the Knoxville area by rail or barge would be far higher than the cost of obtaining these materials from areas near Mobile, creating little incentive for shippers to invest in wood harvesting and terminal facilities above Chickamauga Lock.

Table 22

**COMPARATIVE RAILROAD AND BARGE RATE DATA FOR THE SHIPMENT OF WOOD CHIPS**

| **Barge from Royal Blue, Tennessee, near Caryville, Tennessee** | **Component Charges** | **Rate per Ton ($)** |
|---|---|---|
| | | |
| Existing lock At Chickamauga | Truck to Knoxville | 7.00 |
| | Transfer | 1.6 |
| | Barge to Mobile, AL | 11.87 |
| | Total | 20.47 |
| | | |
| New lock at Chickamauga | Truck to Knoxville | 7.00 |
| | Transfer | 1.60 |
| | Barge to Mobile, AL | 11.68 |
| | Total | 20.28 |
| | | |
| Rail direct to Mobile from Royal Blue | | 12.00 |
| | | |
| | | |
| **Barge from Harriman, TN** | | |
| | | |
| Existing lock at Chickamauga | Total | 10.68 |
| New lock at Chickamauga | Total | 10.49 |
| | | |
| Rail Harriman to Mobile | Total | 12.00 |
| | | |
| **Barge from Vonore, TN** | | |
| | | |
| Existing lock at Chickamauga | Total | 11.29 |
| | | |
| New lock at Chickamauga | Total | 11.10 |
| | | |
| Rail Vonore to Mobile | Total | 14.04 |

Moving downstream 100 miles to Harriman, Tennessee (mile 11 on the Emory River), to a dock that is already permitted for general cargo which includes wood products, the line haul barge rate is $10.49 per ton for a savings of 19 cents per ton given a new lock. A trucking charge and a transloading charge would be added to the line haul barge and rail rates. Thus, although the haul rate between rail and barge to Mobile may appear to be comparable in Table 22, the total rail rate would probably be less than the barge rate because of the lower trucking and transloading charges associated with the remote loading of railroad cars closer to the actual harvesting location.

Similarly, at Vonore, Tennessee, located above Ft. Loudoun Dam, the line haul rate for barge transportation to Mobile is $11.10 per ton as compared to a rail rate of $14.04. However, adding the truck and transloading charge, the total delivered cost of a barge load of wood chips would be much higher. In fact, the transportation charge is estimated to be $26,000 for each barge load of wood chips (1250 tons x $20.50). The transportation cost of an eight barge tow would be $208,000 from Vonore to Mobile even with a new lock. Shippers closer to Mobile are already moving wood chips there at a total cost that is not burdened by a relatively high transportation cost component.

It must be reemphasized that the cost of shipping by rail or barge would be far higher than the cost of obtaining these materials from areas near Mobile, creating no incentive for shippers to invest in wood harvesting and terminal facilities above Chickamauga Lock.

### *Intermodal Shift Impacts*

4.2.1 Construct New 110 x 600 Foot Lock Alternative

About 2.1 million tons of traffic are locked through Chickamauga Dam annually, and the TVA/USACE survey has indicated that an additional 8.6 million tons would be diverted from the roadway to the lock by the year 2000 if a 110 x 600 foot lock were constructed there. Shifting 8.6 million tons of potential traffic to the new lock could result in environmental benefits. These are shown in Table 23. Over the life of the project, building a new lock could save 577 million gallons of diesel fuel over and above the fuel savings (by not shipping by overland modes) associated with the traffic presently moving through the existing Chickamauga Lock. Total possible fuel savings from the existing and potential traffic total 719 million gallons over the life of the project. Building a new lock would provide a safer transportation climate for the general public because of fewer trucks on the affected roadbeds that are already overcrowded. Over the life of the project there would be an expected 5085 fewer accidents and 775 fewer fatalities. Shifting the potential traffic to the new lock could potentially result in an additional decrease of 4078 accidents and 622 fatalities.

Barging the actual and potential traffic would yield expected annual average impacts of (1) 14.4 million gallons of reduced fuel consumption, (2) decreases in particulate air emissions, (3) 101.7 fewer accidents, and (4) 15.5 fewer fatalities. The magnitude of the total traffic is 10.6 million tons. Moving this quantity by the tractor-semi trailer mode would require 942,000 two-way movements per year. Similarly, 1060 trains hauling 10,000 tons per train would be required annually to move this quantity of commodities.

Table 23

BENEFICIAL ENVIRONMENTAL IMPACTS OF INTERMODAL TRAFFIC SHIFTS
ACCRUING TO CONSTRUCTION OF
A 110 X 600 FOOT NAVIGATION LOCK AT CHICKAMAUGA DAM

| | Lock Closure | Potential Traffic Impacts | Total Impacts |
|---|---|---|---|
| | | | |
| Fuel Use in millions of gallons | 143 | 577 | 719 |
| | | | |
| Average per year | 2.9 | 11.5 | 14.4 |
| | | | |
| Air Pollution in Thousands of Tons | 155 | 629 | 784 |
| | | | |
| Average per year | 3.1 | 12.6 | 15.7 |
| | | | |
| Accidents | 1007 | 4078 | 5085 |
| | | | |
| Average per year | 20.1 | 81.6 | 101.7 |
| | | | |
| Fatalities | 154 | 622 | 775 |
| | | | |
| Average per year | 3.1 | 12.4 | 15.5 |
| | | | |

These data are significant for national transportation policy formulation. Most of the traffic moving into and out of the upper Tennessee River area that would potentially divert to barge transportation move in a north-south direction. The White Lily Flour Company is an example of a potential user that has used barge transportation in the past. This and many other companies are using Interstate 75 between Knoxville and Chattanooga. And given that portions of this route are already operating close to or above capacity, the diversion of a significant quantity of traffic from the truck to barge mode would result in less congestion on the interstate system, less fuel consumption, less air pollution, fewer accidents, fewer fatalities, less damage to the roadbed, and less public expenditure to maintain the roadbed.

### 4.2.2 No Action Alternative

The environmental impacts of intermodal transportation shifts for the alternative in which the lock at Chickamauga Dam is closed to navigation are shown in Table 24. If the lock was closed to navigation and remained closed for 50 years (the expected life of a new lock) transportation of the same commodities with the same origin-destination combinations would require 142 million additional gallons of diesel fuel or an average annual additional increase of 2.8 million gallons. There would also be an expected increase of 155 thousand tons of exhaust emission or 3.1 thousand additional tons per year. The expected increase in accidents would be 1007 or 20 per year, and the increase in expected fatalities would be 154 or three per year.

Table 24
INTERMODAL TRANSPORTATION IMPACTS
EXPECTED WITH CLOSURE OF EXISTING NAVIGATION LOCK
AT CHICKAMAUGA DAM

| | Fifty Year Total | Average Annual |
|---|---|---|
| Fuel Use—millions of gallons | 142 | 2.8 |
| Air Pollution—thousands of tons | 155 | 3.1 |
| Accidents | 1007 | 20.0 |
| Fatalities | 154 | 3.0 |

### 4.2.3 Construct New 60 x 360 Foot Lock Alternative

The intermodal shift impacts from the 60 x 360 foot lock reflect the fact that, with the reliability of locking capabilities, traffic growth would be expected here. Environmental impacts associated with the 60 x 360 foot lock would include: 24 fewer accidents, four fewer fatalities, and 3.3 million gallons less diesel fuel consumption annually.

#### 4.2.4 Construct New 75 x 400 Foot Lock Alternative

The intermodal shift impacts from the 75 x 400 foot lock reflect the fact that, with the reliability of locking capabilities, traffic growth would be expected here. Environmental impacts associated with the 75 x 400 foot lock would include: 46 fewer accidents, seven fewer fatalities, and 6.5 million gallons less diesel fuel consumption annually.

### 4.3 Recreation

#### 4.3.1 Construct New 110 x 600 Foot Lock Alternative

##### 4.3.1.1 Construction Impacts

Recreational impacts during construction of a 110 x 600 foot lock would be minimal. While the cofferdam is in place, there would be limited space in the lower lock approach for recreational vessels awaiting lockage. This may require TVA to exercise some sort of traffic control to alleviate potential conflicts between commercial and recreational traffic.

##### 4.3.1.2 Operational Impacts

Construction of a new 110 x 600 foot lock at Chickamauga Dam would allow the boating public to continue to navigate between Nickajack and Chickamauga Reservoirs. Growth in Chattanooga's riverfront activities as a result of phased implementation of the riverfront development plan should result in increased boating activity at the lock which could be accommodated with the new lock in place. In addition, the larger lock size would allow for more efficient lockage of recreational boaters.

#### 4.3.2 No Action Alternative

Closing or plugging the lock would halt the movement of recreational boaters through Chickamauga Dam, and the associated economic benefits described in Section 4.1 would be lost.  Given that Chickamauga Lock is one of the most heavily used facilities for recreational boating on the inland water system, this will have long-term negative impacts on recreational boating patterns in the immediate lock area and, therefore, on some of the cultural events.

### 4.3.3 Construct New 60 x 360 Foot Lock Alternative

#### 4.3.3.1 Construction Impacts

Construction impacts on recreation associated with the 60 x 360 foot lock would be similar to those associated with the 110 x 600 foot lock described in Section 4.3.1.1.

#### 4.3.3.2 Operational Impacts

Replacing the existing lock with one of the same size would maintain the status quo, and there would be no impacts to recreation.  Even with increased traffic due to possible growth of commercial activity, recreational boaters are allowed passage every fourth lock-through.

### 4.3.4 Construct New 75 x 400 Foot Lock Alternative

#### 4.3.4.1 Construction Impacts

Construction impacts on recreation associated with the 75 x 400 foot lock would be similar to those associated with the 110 x 600 foot lock described in Section 4.3.1.1.

4.3.4.2 Operational Impacts

Replacing the existing lock with a 75 x 400 foot lock would allow recreational boaters continued navigation through the dam between the two reservoirs. Even with increased traffic due to possible growth of commercial activity, recreational boaters are allowed passage every fourth lock-through.

## 4.4 Land Use

4.4.1 Construct New 110 x 600 Foot Lock Alternative

4.4.1.1 Construction Impacts

The SR 153 bridge across the lock would remain open during construction and Lake Resort Drive will be relocated (as described in Section 2.1.1). As part of the relocation of Lake Resort Drive, two new bridges will be built, one over North Chickamauga Creek and one for grade separation between Lake Resort Drive and the permanent access road to the North Chickamauga Creek Greenway. Improvements will be made to the intersection of Access Road and Lake Resort Drive which will facilitate safer access to SR 153.

There will be a temporary service road connecting the Dupont construction laydown area with the lock cofferdam site and dredged material disposal area. This road will be used to move construction equipment and materials between the laydown areas, cofferdam, and disposal area. Fugitive dust emissions generated from the use of this road would be controlled through the use of reasonable precautions such as road wetting. At the end of construction, the downstream portion of the service road would be removed, and the remaining portion would serve as access to the North Chickamauga Creek Greenway. A permanent parking area would be constructed to provide access to the visitors' overlook.

4.4.1.2 Operational Impacts

No direct land use impacts would occur at nearby industries or the community college near Chickamauga from the operation of a 110 x 600 foot lock. However, marginal secondary impacts from development of industrial and transportation facilities could be expected over time on the reservoir upstream of the new lock.

In the larger region around the reservoir there could be impacts associated with increased shipping of commodities through the lock resulting mainly from intermodal shifts. Coal is the dominant commodity, accounting for about 50 percent of the total shipping tons. This traffic would be induced by a 110 x 600 foot lock. This coal is from deep mines in eastern Kentucky and would move by barge out of the Chickamauga pool to utilities in the southeastern United States. This coal is essentially low-sulfur/high BTU coal that will be used to meet the requirements of Phase II under Title IV of the Clean Air Act. The impacts of any increase in coal mining would be addressed by existing federal and/or state regulations.

### 4.4.2 No Action Alternative

Localized land use impacts due to construction associated with the plugging of the lock would be confined to the immediate area of the lock.

Once construction activities are complete and the lock is plugged, no long-term land use impacts are anticipated to occur.

### 4.4.3 Construct New 60 x 360 Foot Lock Alternative

#### 4.4.3.1 Construction Impacts

Construction impacts on land use associated with the 60 x 360 foot lock would be similar to the 110 x 600 foot lock (Section 4.4.1.1).

#### 4.4.3.2 Operational Impacts

Replacing the existing 60 x 360 foot lock with one of the same size would maintain the status quo, and there would be no impacts to land use.

#### 4.4.4 Construct New 75 x 400 Foot Lock Alternative

##### 4.4.4.1 Construction Impacts

Construction impacts on land use associated with the 75 x 400 foot lock would be similar to the 110 x 600 foot lock (Section 4.4.1.1).

##### 4.4.4.2 Operational Impacts

Operational impacts associated with the 75 x 400 foot lock would be similar to those for the 110 x 600 foot lock, but of a lesser degree.

### 4.5 Water Quality

Construction activities performed beyond the area within the cofferdam will be similar for all sizes of locks. Within the cofferdam itself, although the size of area will vary, no additional significant impacts are expected. Dredging activity also will be the same for all size lock alternatives.

#### 4.5.1 Construct New 110 x 600 Foot Lock Alternative

##### 4.5.1.1 Construction Impacts

Sediment disturbance during blasting and removal of portions of the river bed for construction and channel dredging will suspend some soil and rock material. Bank construction activity may also cause erosion during heavy rainfall, which could wash excavated or hauled material into the reservoir. However, use of silt fences and other barriers constructed downstream of exposed material would prevent or minimize such problems.

Construction of the lock and dredging are not likely to impact the quality of the potable water supply provided by the Tennessee American Water Company to the city of Chattanooga. Water quality sampling will be performed downstream of any construction activities to allow for any necessary mitigation.

Construction activities are also expected to include point source discharges from settling basins and spoil disposal areas. These activities are subject to state NPDES permit requirements, and no adverse effects on water quality are expected. A State of Tennessee Spill Prevention Control and Countermeasures (SPCC) plan will be developed if the amount of fuel stored on-site exceeds 1320 gallons in aggregate or 660 gallons in one container.

#### 4.5.1.2 Operational Impacts

With construction of the 110 x 600 foot lock, the number of tows and the horsepower of the towboats would increase. Any turbidity due to this increased navigation activity would be expected to be temporary and insignificant.

Regional industrial activity may increase somewhat due to the larger lock. Point source discharges associated with such activity would be subject to regulatory controls.

### 4.5.2 No Action Alternative

Existing water quality conditions will persist until the lock is plugged. Following closure of the lock, there may be some improvement in water quality because of the lack of barge traffic disturbances and a restriction of economic development upstream from the dam. As the lock chamber and land and river wall culverts are plugged with concrete, minimal amounts of gravel and concrete may enter the river. Turbidity associated with the plugging would be localized and temporary. No operational impacts on water quality are expected. Water quality monitoring would be conducted during construction to guard against water quality impacts.

### 4.5.3 Construct New 60 x 360 Foot Lock Alternative

#### 4.5.3.1 Construction Impacts

Water quality impacts associated with sediment disturbance and bank construction activity will basically be the same or similar to the larger lock size as described in Section 4.5.1.1. Water quality sampling will also be performed to monitor any construction effects.

#### 4.5.3.2 Operational Impacts

Changes in existing operational impacts on water quality are not expected.

### 4.5.4 Construct New 75 x 400 Foot Lock Alternative

#### 4.5.4.1 Construction Impacts

Water quality impacts associated with sediment disturbance and bank construction activity will basically be the same or similar to the larger lock size as described in Section 4.5.1.1. Water quality sampling will also be performed to monitor any construction effects.

#### 4.5.4.2 Operational Impacts

With construction of the 75 x 400 foot lock, the number of tows and the horsepower of the towboats could increase. Any turbidity due to this increased navigation activity would be expected to be temporary and insignificant.

Regional industrial activity may increase somewhat due to the larger lock. Point source discharges associated with such activity would be subject to regulatory controls.

## 4.6 Air Quality

### 4.6.1 Construct New 110 x 600 Foot Lock Alternative

#### 4.6.1.1 Construction Impacts

Air pollution impacts from the construction project would likely be localized and temporary. For example, transitory air quality impacts would be expected if natural vegetative materials were open-burned during the construction phase. Meeting state and Chattanooga-Hamilton County guidelines and regulations concerning open burning would ameliorate any impacts. TVA would not conduct open burning whenever an air stagnation advisory or a special dispersion statement issued by the National Weather Service is in effect for the area.

Use of a concrete batch plant on-site will generate dust and require a state or local air pollution control permit. Emissions from fossil fuel combustion in construction equipment and increased traffic during construction would have a minor and temporary impact on air quality in the vicinity of the project. Fugitive dust emissions resulting from the operation of construction equipment under dry conditions will be minimized through the use of "reasonable precautions" as required by local and state air regulations. Wetting road surfaces would be an example of a dust control measure to address the abatement of fugitive emissions.

#### 4.6.1.2 Operational Impacts

Towboats are powered through the combustion of fossil fuels. No significant increase in air emissions is expected from the higher barge traffic due to the operation of a 110 x 600 foot lock.

In fact, $SO_x$ and $NO_x$ emissions would be reduced because of the efficiency of barge transportation. An eight barge tow equates to over 530 tractor-semi trailer movements. There are also improvements in efficiency over rail carriage. For example, salt generally moves in five 100 ton-car moves which could be compared to an eight barge tow which would carry 12,000 tons. In this case, 24 rail movements would be equivalent to one barge tow. Further decreases in net air pollution could be expected to occur with construction of a new lock given the tow size could be as great as 15 barges. Additionally, since tows operating on the upper Tennessee River would transit the lock about six hours faster with fewer delays, incremental air quality benefits would be expected because of reduced processing time.

4.6.2 No Action Alternative

Minor impacts to air quality associated with increased construction traffic and construction work would be expected in the immediate lock area during plugging of the existing lock. The intermodal transportation shift is expected to increase the consumption of fossil fuel by approximately 2.8 million gallons per year. This shift is estimated to increase emissions of certain criteria pollutants along the Knoxville-Chattanooga corridor by amounts indicated below: [19]

Particulates: 3100 tons per year
Nitrogen Oxides: 332.2 tons per year
Sulfur Dioxide: 15.5 tons per year

The increase in emissions of particulates and nitrogen oxides (ozone precursor) from implementing the no action alternative would be significant.

4.6.3 Construct New 60 x 360 Foot Lock Alternative

4.6.3.1 Construction Impacts

Air quality impacts from construction of 60 x 360 foot lock would be similar to the impacts described in Section 4.6.1.1 for the 110 x 600 foot lock. However, these impacts are expected to occur over a shorter duration because of the smaller size of the lock.

4.6.3.2 Operational Impacts

Operation of the new 60 x 360 foot lock would reduce emissions of particulates, nitrogen oxides, and sulfur dioxide in amounts greater than those shown in Section 4.6.2 by maintaining navigation through the new lock and inducing some new traffic growth due to reliability of the new structure. Minor improvements as described in Section 4.6.1.2 would also be realized.

---

[19] The emissions of $NO_x$ and $SO_x$ were based on the assumption that all traffic at the Chickamauga Lock would get diverted to truck transportation in 93,000 loads at 22.5 tons per load. The average length of a one-way trip is assumed to be 140 miles. The

### 4.6.4 Construct New 75 x 400 Foot Lock Alternative

#### 4.6.4.1 Construction Impacts

Air pollution impacts from construction of 75 x 400 foot lock would be similar to the impacts described in Section 4.6.1.1 for the 110 x 600 foot lock. However, these impacts are expected to occur over a shorter duration because of the smaller size of the lock.

#### 4.6.4.2 Operational Impacts

Operation of the new 75 x 400 foot lock would reduce emissions of particulates, nitrogen oxides, and sulfur dioxide in amounts greater than those shown in Section 4.6.2 by maintaining navigation through the new lock and inducing some new traffic growth due to reliability of the new structure. Minor improvements as described in Section 4.6.1.2 would also be realized.

---

methodology for determining emissions of particulate matter derived from Newstrand (1992).

## 4.7 Aquatic Resources

### 4.7.1 Construct New 110 x 600 Foot Lock Alternative

#### 4.7.1.1 Construction Impacts

The construction of the new lock, by itself, is not expected to affect the resident aquatic life. The plankton community would not be affected because of the transient nature of the populations. The short-term increase in turbidity associated with lock construction would have little or no adverse impact to submersed aquatic macrophytes.

Based on information collected during the 1990 mussel survey in the Chickamauga Dam tailwater (Jenkinson, 1993), very few live mussels occur within the lock construction area, and only a few more occur where the approach wall to the new lock is proposed to be built. All of the mussels found in these areas were representatives of the two most abundant and widespread species present in the tailwater (elephantear, *Elliptio crassidens*, and pink heelsplitter, *Potamilus alatus*). Both of these species are widespread throughout the Tennessee and Mississippi River basins, and neither is protected as an endangered or threatened species by the federal or Tennessee state government.

Dredging to provide access to the new lock and improve the navigation channel downstream from Chickamauga Dam has the potential to affect resident mussel stocks. The 1990 mussel survey of the Chickamauga Dam tailwater (Jenkinson, 1993) specifically included searches of areas where dredging or disposal of dredged material might occur. Results from that survey indicate few mussels occur in many places within the tailwater; however, fairly abundant and diverse mussel assemblages occur in two areas: along the right (descending) shoreline from TRM 469.4 to 470.7 and in midriver from TRM 468.1 to 469.0. The shoreline band of mussels, which extends from the bank out to at least the edge of the present navigation channel, averages approximately six live animals per square meter and includes representatives of 15 species. The midriver band, which exists on a fairly broad shelf adjacent to the right margin of the dredged channel, averages approximately two live mussels per square meter and includes representatives of 13 species. Dredging is proposed for both of these areas; resident mussels would be salvaged and relocated from the area prior to dredging.

In-river disposal of dredged material could occur without impacting substantial mussel stocks. Several areas along the right shoreline that were examined during the 1990 survey (Jenkinson, 1993) were inhabited by few live mussels. Deposition of dredged material along the shoreline in these areas would affect very few resident mussels. Similarly, temporary increases in turbidity and solid material (e.g., sand and gravel) dislodged from the disposal sites would affect very few mussels.

Lock construction and channel dredging would have only local and temporary impacts on the fish community. Sport and commercial fishing in the immediate construction area would be disrupted during the construction phase of the project. Fishing should return to previous levels soon after construction is completed.

Hickman et al. (1989) and St. John (1990) found that sauger do not spawn in the area immediately below either Watts Bar or Ft. Loudoun Dams, but at the first downstream gravel shoal area (approximately five to ten river miles below the dam). It is anticipated that a similar condition exists below Chickamauga Dam, with spawning most likely occurring at Williams Island (15 river miles downstream). It is possible the spawning site in upper Chickamauga Reservoir is the location where Nickajack sauger spawn. In either case, disposal of dredge material in the vicinity of the new lock is not expected to adversely impact sauger spawning success.

#### 4.7.1.2 Operational Impacts

Operation of the new lock and subsequent increase in barge traffic would have little effect on most types of aquatic life in the tailwater or Chickamauga Reservoir. Changes in discharge patterns resulting from the new lock and spillway modification through the dam and anticipated increases in navigation traffic are projected to have extremely small impacts on flows and substrate conditions. The small extent of these changes indicates that operational impacts on the plankton and benthos would be minimal. Macrophyte colonies close to the navigation channel could be affected by increased turbidity;

however, these impacts would be minor in comparison with similar impacts that occur as a result of natural flood events.

After the new lock has been built, operation of the project would not be anticipated to have any effect on mussel resources in the Chickamauga Dam tailwater or reservoir. Mussels in the tailwater which were not impacted by construction would not be affected by minor changes in flow or navigation traffic and would continue to exist as they did before the project was started. The few remaining mussels in the reservoir would not be impacted by increases in navigation traffic.

Operation of the new lock is unlikely to have any substantial impact on most fish species in the Chickamauga Dam tailwater or reservoir. However, depending upon its design, the new lock could have important effects on migratory species, particularly sauger. Scott and Hevel (1993) interpret results from several studies to show that sauger are able to move easily through some locks but not others. Location and configuration of the downstream discharge ports appear to be the important difference between various lock designs as they affect fish passage. Discharge structures located near the river bottom in areas with substantial current apparently attract sauger into a lock. These features would be incorporated in the design of a new Chickamauga Lock. These features would facilitate upstream sauger movements and, perhaps, augment sauger populations both downstream and upstream of Chickamauga Dam. Other migratory species may also benefit by gaining access to spawning areas above Chickamauga Dam.

Very little sediment in Chickamauga tailwater or Chickamauga Reservoir would be resuspended by increased barge traffic. (Bender and Proctor, 1992) However, even if resuspension were to occur, the extremely low levels of toxic substances in the sediments would not have a detectable effect on the water or aquatic life.

TVA is aware of the problems which large zebra mussel infestations could cause for a new lock at Chickamauga Dam. The design of the new lock will include concepts to minimize zebra mussel fouling of underwater structures.

#### 4.7.2 No Action Alternative

Plugging the existing lock would have minimal impacts on most aquatic life in Chickamauga Reservoir and the dam tailwater. Plugging the lock would, however, create a barrier for migratory fish species such as sauger, white bass, buffaloes, and redhorses. This option would prevent migration of fish from Nickajack Reservoir to upstream spawning areas in Chickamauga Reservoir. If these species are prevented from reaching Chickamauga Reservoir, they probably would attempt to spawn in Nickajack Reservoir, which is considered less favorable for spawning success than Chickamauga Reservoir. Downstream movement of fish from Chickamauga Reservoir could still occur during periods of high flow when the dam spillway gates are opened and through the turbines during periods of hydro-generation.

Adoption of the no action alternative would not include any way to build structural features to assist fish in their upstream migrations. Nonstructural mitigation measures could possibly be implemented, such as stocking programs and, potentially, tailwater habitat enhancements.

#### 4.7.3 Construct New 60 x 360 Foot Lock Alternative

##### 4.7.3.1 Construction Impacts

The construction of a 60 x 360 foot lock would have similar impacts on aquatic life as those associated with a 110 x 600 foot lock as described in Section 4.7.1.1.

#### 4.7.3.2 Operational Impacts

The operation of a 60 x 360 foot lock would have similar impacts on aquatic life as those associated with a 110 x 600 foot lock as described in Section 4.7.1.2.

### 4.7.4 Construct New 75 x 400 Foot Lock Alternative

#### 4.7.4.1 Construction Impacts

The construction of a 75 x 400 foot lock would have similar impacts on aquatic life as those associated with a 110 x 600 foot lock as described in Section 4.7.1.1.

#### 4.7.4.2 Operational Impacts

The operation of a 75 x 400 foot lock would have similar impacts on aquatic life as those associated with a 110 x 600 foot lock as described in Section 4.7.1.2.

## 4.8 Wetlands and Wetland Wildlife

### 4.8.1 Construct New 110 x 600 Foot Lock Alternative

#### 4.8.1.1 Construction Impacts

The only wetlands identified in the vicinity of Chickamauga Dam project are on the left bank shoreline (TRMs 468.8L to 469.4L on Nickajack Reservoir). These wetlands were identified during preliminary field inspections and classified and mapped using the classification system of Cowardin, et al. (1979). Dredging activities will occur on the opposite side of the navigation channel, and the dredged material will be placed on the right descending bank.

During the development of site plans for construction which included plans for placement of dredged material (Figure 14), it was determined that the left bank shoreline on Nickajack Reservoir would not be needed to accomplish the project.

page for figure 14

Therefore, no direct or indirect impact to wetlands is expected. If needed, additional discussions and follow-up field investigations involving representatives of TVA's Land Management, Navigation, and Fossil and Hydro Project staffs and USACE would be arranged to obtain Clean Water Act Section 404 permits and to develop detailed wetlands impact avoidance, minimization, or mitigation strategies.

#### 4.8.1.2 Operational Impacts

No impacts on wetlands are expected from the operation of a new 110 x 600 foot lock.

### 4.8.2 No Action Alternative

No impact expected because of the lack of wetlands in the project vicinity.

### 4.8.3 Construct New 60 x 360 Foot Lock Alternative

#### 4.8.3.1 Construction Impacts

Any potential impact to wetlands from construction of a 60 x 360 foot lock will be addressed as described for the 110 x 600 foot lock.

#### 4.8.3.2 Operational Impacts

No impacts on wetlands are expected from the operation of a 60 x 360 foot lock.

### 4.8.4 Construct New 75 x 400 Foot Lock Alternative

#### 4.8.4.1 Construction Impacts

Any potential impact to wetlands from construction of a 75 x 400 foot lock will be addressed as described for the 110 x 600 foot lock.

#### 4.8.4.2 Operational Impacts

No impacts on wetlands are expected from the operation of a 75 x 400 foot lock.

## 4.9 Upland Vegetation and Wildlife

### 4.9.1 Construct New 110 x 600 Foot Lock Alternative

#### 4.9.1.1 Construction Impacts

Most of the vegetation in the construction and laydown area would be disturbed or removed during construction of the proposed facility. The various plant species occurring on the site and the vegetative communities they comprise (lawns, pine plantations, hardwood forests, riparian zone, and brushy areas) are well represented in the local area. No unusual community types or areas of critical habitat would be affected as a result of construction and operation of the proposed facility.

After construction is complete, any disposal areas would be reclaimed through plantings and natural plant succession. Wildlife habitat lost during construction would be partially restored through site revegetation by seeding, planting, and through natural succession.

On the existing lock parking area (Figure 2), limited upland wildlife populations would be displaced by construction activities on this site, and the marginal habitat that the mowed lawn areas provide would be eliminated. After construction and disposal of any excavated material is complete, this area will be utilized as a parking area.

At the Chickamauga Lock construction area and TVA dredge material disposal site (Figure 6), construction activities would result in the displacement and loss of populations of most wildlife species occupying these areas. None of the upland wildlife species present on these sites are unique to the area. Populations of species that occupy or use lawn and brushy habitats would become reestablished relatively quickly following post-construction reclamation. Clearing of the loblolly pine plantation would result in the loss of wildlife species utilizing this area. Clearing and construction could also reduce populations of certain species requiring extensive, unbroken forested habitats such as that occurring on the adjacent Big Ridge tract. Such large tracts of forest are uncommon in the local area. This impact would be reduced by maintenance of the 250 foot forested buffer strip described in Section 4.10.1.1.

At the Dupont property site (Figure 6), upland wildlife populations would be temporarily displaced or destroyed by disposal activities on this site. However, none of the species using this area are unique to the area. Except for the deciduous woodlots, the habitats present would likely be quickly restored during post-construction reclamation.

In regard to the river bank excavation area (between TRMs 470.1R and 470.8R), approximately 11.2 acres of wooded shoreline (riparian) habitat would be destroyed. Adverse modification of this area would be offset, i.e., mitigated, by replanting native riparian tree species along the top of the new cut bank, as site conditions and adjacent land uses allow. Additionally, the latest natural landscape techniques would be applied, as appropriate, to protect the recontoured shoreline from erosion, provide habitat for riparian wildlife species, and enhance shoreline aesthetic values.

#### 4.9.1.2 Operational Impacts

No impacts are expected from the operation of a new 110 x 600 foot lock.

### 4.9.2 No Action Alternative

Minimal local impact from construction associated with plugging of the existing lock.

### 4.9.3 Construct New 60 x 360 Foot Lock Alternative

#### 4.9.3.1 Construction Impacts

The impact to upland vegetation and wildlife from construction of a 60 x 360 foot lock would be the same as a 110 x 600 foot lock.

#### 4.9.3.2 Operational Impacts

No impacts are expected from the operation of a new 60 x 360 foot lock.

### 4.9.4 Construct New 75 x 400 Foot Lock Alternative

#### 4.9.4.1 Construction Impacts

The impact to upland vegetation and wildlife from construction of a 75 x 400 foot lock would be the same as a 110 x 600 foot lock.

#### 4.9.4.2 Operational Impacts

No impacts are expected from the operation of a new 75 x 400 foot lock.

## 4.10 Threatened and Endangered Species

### 4.10.1 Construct New Lock Alternative

#### 4.10.1.1 Construction Impacts

***Aquatic***

As indicated in Section 3.10.1, three endangered, threatened, or candidate aquatic species are known to persist in the Chickamauga Dam tailwater. Paddlefish and snail darters in this part of the Tennessee River would be affected very little by construction of a new lock. The minor and localized increases in turbidity and bed load caused by the construction might cause some individuals of these species to avoid active work sites for a few days; however, these situations would be rare events. These fish species in the Chickamauga Dam tailwater would not be affected by construction of the new lock or other related facilities.

The pink mucket, the third protected or candidate species known from this tailwater, was found during the 1990 survey (Jenkinson, 1993). Construction of the new lock approach wall would not affect members of this species; however, dredging to improve the navigation channel either along the right shoreline just downstream from the dam or in midriver between TRMs 467.0 - 469.0 would destroy habitat in which this species occurs. Potential impacts to this species would be mitigated, in part, by relocating the affected animals to other suitable habitat in this river reach. Depending on local conditions, approximately 50 percent of the relocated animals are expected to remain in the transplant site one year after they are moved. Additional mitigation measures may be determined during Endangered Species Act consultation with the U.S. Fish and Wildlife Service (USFWS).

This project would have little or no effect on survival of the pink mucket as a species because other populations persist on the Tennessee, Cumberland, Ohio, and Green Rivers (Ahlstedt, 1985). A specimen of this species found along the left bank indicates that continued survival of the species in this tailwater also would not be seriously affected by this project.

### *Terrestrial*

No populations of federal or state listed plant species or plant species under review for federal or state listing are known from any sites proposed for disturbance.

Because individuals of mountain skullcap resident species occur within 150 feet of the proposed spoil disposal site, canopy removal on-site would adversely impact the population. Consequently, a wooded buffer zone approximately 100 feet wide will be left intact on the disposal site proper. This would ensure the maintenance of a contiguous forested buffer approximately 250 feet wide between the closest elements of the endangered plant population and the edge of the disposal site. The maintenance of this buffer zone should be adequate to ensure no adverse effect on the endangered plants.

Informal discussions with USFWS indicate that the proposed 250 foot buffer would be deemed adequate provided TVA can give assurance that no indirect impacts to the plants would occur.

No adverse impacts to federally listed terrestrial, endangered, or threatened animal species (bald eagle, peregrine falcon, and Tennessee cave salamander) are expected as a result of any of the alternatives.  Construction activities would adversely impact habitat suitable for the state listed red-shouldered hawk and barn-owl; however, because adequate alternative habitat exists, this would not result in significant impacts to locally occurring populations of these species.  No impacts to the green salamander are anticipated.

#### 4.10.1.2  Operational Impacts

No impacts to aquatic and terrestrial threatened and endangered species are expected from the operation of a new 110 x 600 foot lock.

### 4.10.2  No Action Alternative

Impacts to threatened and endangered aquatic and terrestrial species under the no action alternative would not be expected.

### 4.10.3  Construct New 60 x 360 Foot Lock Alternative

#### 4.10.3.1  Construction Impacts

Impacts to threatened and endangered aquatic and terrestrial species from the construction of a new 60 x 360 foot lock would be mitigated as described for the 110 x 600 foot lock.

#### 4.10.3.2 Operational Impacts

No impacts to aquatic and terrestrial threatened and endangered species are expected from the operation of a new 60 x 360 foot lock.

### 4.10.4 Construct New 75 x 400 Foot Lock Alternative

#### 4.10.4.1 Construction Impacts

Impacts to threatened and endangered aquatic and terrestrial species from the construction of a new 75 x 400 foot lock would be mitigated as described for the 110 x 600 foot lock.

#### 4.10.4.2 Operational Impacts

No impacts to aquatic and terrestrial threatened and endangered species are expected from the operation of a new 75 x 400 foot lock.

### 4.10.5 Summary

None of the four alternatives would have more than an insignificant effect on three of the four federally protected or candidate species present in this area. Snail darters and paddlefish would avoid areas where dredging or disposal operations are being conducted, and the mountain skullcap would be protected from impacts by 250 feet of forested buffer. Some pink mucket specimens would be affected by dredging; however, those impacts would be mitigated, in part, by relocating the mussels out of the construction area. Other measures would be taken to complete the mitigation of impacts on the pink mucket. Those measures will be determined by the U.S. Fish and Wildlife Service during formal Endangered Species Act consultation and will be conducted by TVA. This consultation will be concluded and any additional mitigation activities will be underway before the dredging work commences.

## 4.11 Archaeological, Historical, and Cultural Resources

### 4.11.1 Construct New 110 x 600 Foot Lock Alternative

#### 4.11.1.1 Construction Impacts

Based on record/archival check and field reconnaissance, no significant archaeological resources were found in the existing lock parking area and the proposed disposal site on TVA property adjacent to North Chickamauga Creek Greenway (Figures 2 and 6). Shoreline disposal of dredge material at Nickajack Reservoir (TRM 468.8R) would also not affect archaeological resources.

The upland portion of the Dupont construction laydown area contains undisturbed intact soil strata and may contain buried cultural strata. This site will require more intensive testing prior to use.

Because a small strip of shoreline (TRMs 470.1R - 470.8R) would be acquired and subsequently removed, TVA conducted a Phase I archaeological reconnaissance survey on this strip. Two archaeological sites were encountered. One is in the Holocene terrace (Site 40HA397) and definitely within the strip of shoreline scheduled for removal. The site is not eligible for the National Register of Historic Places and does not warrant intensive archaeological testing (Phase II survey). The second site (Site 40HA398) appears to be on the perimeter of the scheduled bank removal and its eligibility status for the National Register of Historic Places is unknown. Prior to any excavation of site 40HA398, intensive archaeological testing would be conducted to determine site significance.

Since site 40HA397 may contain isolated burials; bank removal will be monitored by an archaeologist. Other potential impacts to Site 40HA398 would be avoided either by not using or crossing the site or by buffering vehicular equipment across it.

All new lock alternatives would have an impact on the Chickamauga Dam complex. Therefore, TVA would coordinate the review of this action with state historic preservation officer as mandated by Section 106 of the National Historic Preservation Act.

#### 4.11.1.2 Operational Impacts

No operational impacts are expected.

### 4.11.2 No Action Alternative

No impact expected.

### 4.11.3 Construct New 60 x 360 Foot Lock Alternative

#### 4.11.3.1 Construction Impacts

The impact of constructing a new 60 x 360 foot lock would be essentially the same as for a 110 x 600 foot lock.

#### 4.11.3.2 Operational Impacts

No operational impacts are expected from a 60 x 360 foot lock.

### 4.11.4 Construct New 75 x 400 Foot Lock Alternative

#### 4.11.4.1 Construction Impacts

Impacts associated with the construction of a new 75 x 400 foot lock would be essentially the same as for a 110 x 600 foot lock.

#### 4.11.4.2 Operational Impacts

No operational impacts are expected.

## 4.12 Noise

### 4.12.1 Construct New 110 x 600 Foot Lock Alternative

#### 4.12.1.1 Construction Phase

High explosive blasting would be used to remove rock from within the new lock construction cofferdam and from the navigation channel. High noise levels are expected intermittently for very short durations during the construction phase. All necessary blasting would be done during normal daytime operations.

Rock drilling would be necessary to establish the blasting pattern. The rock would further be reduced in size by jackhammering to facilitate loading and removal. Moderate noise levels would be expected during drilling/jackhammering phases of construction.

Trucks will be used to haul excavated rock from the cofferdam to the disposal area. Concrete for the new lock will be prepared on site at a batch plant and transported to the cofferdam by truck or conveyor. Increased truck traffic and batch plant operation will result in a moderate increase in ambient noise levels. Trucks would be routed through predesigned areas to minimize noise impact on the community.

Operation of heavy equipment (cranes, pile-drivers, bulldozers, front-end loaders, backhoes, work boats, dredging barges, etc.) during the construction phase would generate low to moderate ambient noise levels. Vehicular back-up alarms, required by Occupational Safety and Health Administration (OSHA) regulations, may be particularly noticeable in close proximity to the operation.

As discussed above, construction activities would be expected to have an impact on ambient noise levels. These levels are not expected to have a significant impact on the neighboring community. The closest receptor is a multilevel housing complex located near the river's edge approximately one-half mile upstream from the lock.

#### 4.12.1.2 Operational Impact

Little, if any, change would be expected from present day noise levels during operations due to potential increased traffic on the river.

### 4.12.2 No Action Alternative

Small to moderate increases in ambient noise levels are expected when construction activities to plug the existing lock are conducted. Following lock closure, commodities previously shipped on the river would be expected to be moved by truck or rail which would increase noise levels on the alternate transportation routes in the area. If the alternate route is to loop around the lock, moderate increases in noise levels in the Port of Chattanooga could result.

### 4.12.3 Construct New 60 x 360 Foot Lock Alternative

#### 4.12.3.1 Construction Impacts

Noise impacts from construction of a 60 x 360 foot lock would be similar to the impacts described in Section 4.12.1.1 for the 110 x 600 foot lock. However, these impacts are expected to occur over a shorter duration because of the smaller size of the lock.

#### 4.12.3.2 Operational Impacts

Little, if any, change would be expected from present day noise levels during operations due to potential increased traffic on the river.

#### 4.12.4 Construct New 75 x 400 Foot Lock Alternative

##### 4.12.4.1 Construction Impacts

Noise impacts from construction of a 75 x 400 foot lock would be similar to the impacts described in Section 4.12.1.1 for the 110 x 600 foot lock. However, these impacts are expected to occur over a shorter duration because of the smaller size of the lock.

##### 4.12.4.2 Operational Impacts

Little, if any, change would be expected from present day noise levels during operations due to potential increased traffic on the river.

### 4.13 Flood Control/Floodplain

#### 4.13.1 Construct New 110 x 600 Foot Lock Alternative

##### 4.13.1.1 Construction Impacts

Construction of the new 110 x 600 foot lock would eliminate the use of six existing spillway bays. After removal of the cofferdam, two of those six will return to normal operation. This loss of spillway capacity would not adversely impact upstream flood elevations, up to the 3000 year flood event, which exceeds national flood insurance program requirements. During design of the new and closure of the old lock, TVA will attempt to minimize flood impacts of larger events.

The construction of the lock itself would involve construction within the limits of the 100-year floodplain. By its nature the lock must be in the floodplain and, therefore, is a functionally dependent activity as discussed in the guidance to Executive Order (EO) 11988 (FEMA, 1987). Therefore, there is no practicable alternative to the floodplain location consistent with EO 11988. Adverse impacts will be minimized during design and construction of the project.

The construction of the lock will produce a large amount of material that must be removed from the river and spoiled off site. The proposed spoil site is located within the limits of the identified 100 year floodplain on North Chickamauga Creek. For compliance with Executive Order 11988 several alternative sites were evaluated and documented. This spoil site was selected because the property is already owned by TVA, several of the other sites were also located within the limits of the 100 year floodplain, one of the other alternative sites is being used as a construction laydown area, and the haul costs associated with the use of this site make it the clear choice from an economic standpoint. In addition, there is a benefit to having the additional fill placed on the downstream side of the embankment at this location because it will help to stabilize this area and prevent erosion as part of the future hydrologic fix of Chickamauga Dam. Therefore, there is no practicable alternative to the floodplain siting. Adverse impacts will be minimized through site drainage techniques, by avoiding the area where the endangered mountain skullcap is located, by providing a buffer zone around the site, and by not increasing flood elevations on North Chickamauga Creek because they are controlled by the Tennessee River.

The site development consisting of a new visitors' parking lot, a new visitors' overlook, a new lock operations building, a Corps of Engineers' maintenance building, and a flammable liquid storage building will all be located outside the limits of the 100 year floodplain which is consistent with EO 11988. In addition, all facilities will be located above the TVA Flood Risk Profile.

The project also involves dredging at two locations downstream of the dam. The first area begins at the Norfolk Southern Railway bridge (TRM 470.6) and continues downstream to mile 470.0. The second site is in the Colwell Bend area and extends from TRM 469.0 downstream to mile 466.8. The entire dredging project is proposed within the Tennessee River floodway that has been adopted by the city of Chattanooga. Dry material excavated from this area would be used as fill for the relocation of Lake Resort Drive. Wet earth material will be excavated and stockpiled for reuse as fill to raise proposed parking area. Rock would be spoiled in the spoil area adjacent to North Chickamauga Creek.

For the Colwell Bend dredging project, the proposed method for disposal of the material is for it to be placed along the right bank of the Tennessee River for bank stabilization. EO 11988 requires that alternatives to placement of the material in the 100 year floodplain and floodway be evaluated and documented to support a determination of no practicable alternative to the floodplain siting. Through this process, either another site will be identified, or documentation will be provided for use of this site. If justification can be made for use of this disposal method, it will then be necessary to show how adverse impacts will be minimized. A hydraulic analysis will be performed by a registered engineer to ensure that there would be no increases to the published flood and "with floodway" elevations and floodway widths on the Tennessee River consistent with the city of Chattanooga's floodplain regulations.

The project also involves the construction of two bridges on North Chickamauga Creek. There is an adopted floodway on this creek. It will be necessary for a hydraulic analysis to be performed by a registered engineer to ensure that there would be no increases to the published flood and "with floodway" elevations and floodway widths on North Chickamauga Creek consistent with the city of Chattanooga's floodplain regulations.

Construction of the entire lock project would be consistent with TVA's No Net Loss Guideline for flood control storage. This guideline, established in August 1994, requires that any fill quantities within the flood control storage range must be offset by an appropriate cut or other method to achieve no loss of flood control storage.

#### 4.13.1.2 Operational Impacts

After completion of the new lock, four existing spillway bays would be eliminated. There would be no expected increase in upstream and downstream flood elevations up to the 5500 year flood level.

The removal of four spillway bays would:

1. Impact only those reservoir operations in rare large storm events where the spillway capacity is exceeded and the discharge is controlled by spillway dimensions.

2. Increase the design basis flood levels 1.5 feet at the Sequoyah Nuclear Plant and 0.4 foot at the Watts Bar Nuclear Plant.

3. Increase the likelihood of overtopping the earth embankments and their potential failure. Dam safety studies have identified the overtopping potential and several alternatives are being evaluated to armor the embankment to prevent failure.

4. Not adversely impact TVA's ability to control flood events, up to the 5500 year flood event, even with a loss of 22 percent of spillway bays.

The increase in floodwater depths at the Sequoyah and Watts Bar Nuclear Plants would be reduced by a lift gate at the upstream lock sill which would be designed to be opened and closed in flowing water. A physical model of this design would be built and tested prior to construction. The lift gate would allow the lock to be used as a spillway during very large floods and reduce the effect of the loss of the four spillway bays. Dam safety studies indicate that with the modifications already made at Ft. Loudoun and Tellico projects and the proposed modifications at Watts Bar Dam, the flood levels would be somewhat lower at the Sequoyah and Watts Bar Nuclear Plants.

### 4.13.2 No Action Alternative

Plugging the existing lock forms a permanent water barrier at the dam and gives TVA full control over the upstream reservoir. This is the least cost alternative for solving the water barrier problem at the dam brought on by structural problems at the lock. Flood elevations upstream and downstream of the dam would not be changed under this alternative. In addition, the floodplain areas described in Section 3.13 would not be impacted. There would be no change in existing conditions.

### 4.13.3 Construct New 60 x 360 Foot Lock Alternative

#### 4.13.3.1 Construction Impacts

Construction of the new 60 x 360 foot lock would eliminate the use of five existing spillway bays. After removal of the cofferdam, two of those five will return to normal operation. All other construction impacts under this alternative would be similar to those under Section 4.13.1, construct new 110 x 600 foot lock alternative.

#### 4.13.3.2 Operational Impacts

Operational impacts associated with the construction of a new 60 x 360 foot lock would be essentially the same as those under Section 4.13.1.2 for a 110 x 600 foot lock.

### 4.13.4 Construct New 75 x 400 Foot Lock Alternative

#### 4.13.4.1 Construction Impacts

The construction impacts under this alternative would be similar to those under Section 4.13.1.1, construct new 110 x 600 foot lock alternative.

#### 4.13.4.2 Operational Impacts

The operational impacts under this alternative would be similar to those under Section 4.13.1.2, construct new 110 x 600 foot lock alternative.

## 4.14 Indirect and Cumulative Impacts

Cumulative impacts are those that result from the incremental impact of the proposed action when added to other past, present, and reasonable foreseeable future action. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time.

The indirect and cumulative impacts from intermodal transportation shifts have been discussed in detail in Section 4.2. Some industrial development is expected in the

Chickamauga Reservoir as a result of building a new lock. However, the indirect and cumulative impacts of this industrial development cannot be determined since any forecast of these actions would only be speculative at this juncture. Further, even if this industrial development materializes, it would result from possible decisions of third parties over which TVA has no control or responsibility. In instances where activities associated with this industrial development require site-specific TVA reviews (e.g., 26a reviews), by virtue of the location of the activity on the river, TVA's actions will be subject to future TVA NEPA reviews.

The cumulative impact of the project action when combined with other independent past or presently ongoing projects is insignificant. Cumulative impact of the proposed action when combined with future actions cannot be determined because any such actions are not reasonably foreseeable. TVA has no knowledge of any proposed major regional or interregional highway or railroad track expansions or any major industrial expansions in the general area above Chickamauga Lock and Dam.

# 5.0 Unavoidable Adverse Impacts, Short-Term Uses and Long-Term Productivity, Irreversible and Irretrievable Commitment of Resources, and Environmental Justice

## 5.1 Unavoidable Adverse Environmental Effects

### *Construct New Lock Alternative*

The construction of any of the lock sizes (60 x 360, 75 x 400, or 110 x 600 feet) would result in a loss of habitat for the endangered pink mucket mussel. The loss of some specimens of nonthreatened or endangered mussels during dredging for channel improvements would also be unavoidable as would the habitat for these species. Temporary high noise levels generated from pile-driving activities to construct the cofferdam are expected to have adverse impacts on aquatic and terrestrial species. Other potential adverse environmental impacts identified in this analysis can be substantially avoided or minimized through commitments or mitigation and environmental protection measures which are built into the alternatives.

### *No Action Alternative*

Closure and plugging of the existing Chickamauga Lock would have unavoidable adverse effects. Navigation between Nickajack and Chickamauga Reservoirs would cease, causing significant economic impact to industry and recreation and would isolate the upper Tennessee from the lower river for commercial navigation. This would result in an intermodal shift causing unavoidable, adverse effects on air quality, specifically, particulates, nitrogen oxides, and sulfur dioxide from increased truck and rail traffic.

Plugging of the lock would also block the potential upstream movement of spawning migratory fishes, such as sauger and buffalo. Although methods such as stocking have been tried elsewhere, its effectiveness in mitigating the impact on sauger and buffalo is uncertain. Hence, for all intents and purposes, this would be an unavoidable adverse impact.

## 5.2 Relationship Between Short-Term Uses of the Environment and Maintenance and Enhancement of Long-Term Productivity

Short-term impacts are those that would occur during lock construction. Impacts associated with lock operation are considered to be long-term.

During the five-year construction period, some navigation traffic congestion would be expected because the cofferdam would eliminate part of the area that is presently available for recreational boats while waiting to lock upstream. Further, dredging to widen the channel may temporarily disrupt commercial traffic below the lock. Lockage times could increase during these periods, and traffic control might be necessary during periods of high recreational activity. As congestion occurs and processing time increases, shipper costs could increase and industrial productivity may decline.

Construction of a new lock would require short-term use of the environment and a variety of resources, such as land, fuel, construction materials, and labor. Also, construction would commit lands to a temporary service road, disposal sites, and concrete batch plant operations. Construction would also result in temporary impacts to ambient noise levels, air quality, water quality, and aquatic life.

Long-term productivity may result in more efficient operation of shippers. In a competitive environment, this increased efficiency could result in reduced growth in prices. After new lock construction, shipper costs for barge users may fall. Transportation rates for certain other industrial users may also fall as overland modes adjust their rates to reflect lower barge transportation rates. All things being equal, lower transportation rates may increase industrial productivity.

Furthermore, a 110 x 600 foot lock removes traffic from the nation's highway system and makes these arteries less congestive. This expected intermodal shift could result in reduced air emissions, fuel usage, and traffic fatalities. Further, this shift could result in less frequent maintenance and repairing of roads.

By constructing a new lock instead of plugging the existing lock at the end of its life, TVA will preserve navigation along 297 miles of inland waterway above Chickamauga Lock. The loss of commercial traffic on this waterway would cost the nation $25 million annually.

New lock construction would provide for more efficient recreational lockages during congested periods, especially those associated with special events.

## 5.3 Irreversible and Irretrievable Commitments of Resources

A commitment of resources is irreversible when its primary or secondary impacts limit future options for a resource. An irretrievable commitment refers to the use or consumption of resources, neither renewable nor recoverable for future use.

The proposed action would result in the use of nonrenewable resources such as construction materials, fuel, and energy. The construction materials used in the building of the lock would be concrete and steel. The concrete will probably be irretrievably lost; however, the steel used in constructing the gates and valves could be recycled at the end of its life. Similarly, the gates and valves of the existing lock, removed when the lock is plugged, could be recycled. Energy used in the form of diesel fuel, gasoline, and oil for construction equipment and transportation vehicles would be irretrievably committed.

The Chickamauga Dam complex is a cultural resource subject to Section 106 review. Changes in this complex would result in some irretrievable loss of this cultural resource.

Land committed to road relocations, bridges, spoil disposal sites, visitor facilities, and parking areas would not be irreversible. However, the materials used in the construction of these land-based facilities would likely be irretrievably lost.

**5.4 Environmental Justice**

Executive Order No. 12898 directs certain federal agencies to consider environmental justice in the environmental reviews of their programs and activities. Although TVA is not one of the agencies designated in the Executive Order, it has considered the issue of environmental justice in the context of this proposed action.

Environmental justice refers primarily to ensuring that no segment of the population bears a disproportionate burden of health and environmental impacts of society's activities. Some studies suggest that poor, predominantly minority populations are exposed disproportionately to adverse health and environmental impacts because hazardous waste management facilities and other industrial facilities with potentially impassive air and water releases are sighted in their communities. Other studies dispute these findings.

The siting of industrial facilities has raised the most concern with respect to environmental justice. As discussed above, the primary effect of the larger lock is intermodal shifts in transportation from a reduction in transportation costs. This may spur some expansion of existing industries or location of new industrial facilities upstream of the lock. A prediction of the number of these expansions or new facilities would be speculative and is not quantifiable at this time. However, when these situations occur, they would receive site-specific environmental reviews by TVA if they are locating along the river. These additional environmental reviews will be conducted and environmental justice concerns and effects addressed in those reviews as appropriate. Depending on the nature of the particular proposal and the kinds of impacts it may have, TVA will make a special effort to involve potentially affected low-income and minority populations in the review.

# 6.0 Supporting Information

## 6.1 List of Preparers

Anne Aiken
Position: Environmental Engineer, Water Management
Education: M.S., Environmental Engineering
Experience: 6 years water quality analysis, TVA

Barry L. Barnard
Position: Specialist, Senior Environmental Engineer
Education: B.S., Chemical Engineering
Experience: 16 years air quality assessments, TVA
9 years, State Regulatory Agency

Thomas E. Beddow
Position: Wetlands Ecologist and Wildlife Biologist, Land Management
Education: B.S., Wildlife and Fisheries Management
Experience: 25 years, wildlife and fisheries Biology, TVA
U.S. Fish and Wildlife Service, U.S. Army Corps of
Engineers, Kentucky, Division of Strip Mine Reclamation

Merlynn D. Bender
Position: Civil Engineer, Engineering Services
Education: M.S., Civil and Environmental Engineering
Experience: 10 years water resource engineering, TVA
2 years, hydraulic research, University of Minnesota

Larry G. Bray

Position: Technical Specialist, Water Management

Education: Ph.D., Economics

Experience: 14 years navigation planning, TVA
10 years economic development and power resources planning, TVA

Johnny Buchanan

Position: Aquatic Biologist, Water Management

Education: B.S., Biology
M.S., Zoology

Experience: 30 years aquatic biology, TVA

Louis E. Buck

Position: Technical Specialist, Flood Protection

Education: M.S., Civil Engineering, M.B.A.

Experience: 14 years flood hazard analysis, TVA

Donnie R. Butler

Position: Manager, Occupational Hygiene

Education: M.S., Industrial Hygiene

Experience: 25 years occupational health and safety, TVA

Joseph L. Collins

Position: Botanist, Land Management

Education: Ph.D., Plant Taxonomy

Experience: 20 years, Botanist for TVA Heritage Project

George G. Conner

Position: Technical Specialist, Navigation, Water Management

Education: B.S., Civil Engineering

Experience: 29 years navigation operations, TVA

Steven D. Cottrell
Position:  Wildlife Biologist, Land Management
Education:  M.S., Wildlife Management
Experience:  22 years wildlife research and management, TVA

Stanford E. Davis
Position:  Environmental Scientist
Education:  B.S, Wildlife and Fisheries
Experience:  21 years wildlife management, TVA

George R. Deveny
Position:  Regional Planner, Community Partnerships
Education:  B.S., Civil Engineering, Master of Regional Planning
Experience:  24 years socioeconomic and land use impact assessments, TVA

Charles H. Ellenburg
Position:  Recreational Planner, Land Management
Education:  B.S., Recreation and Park Administration
Experience:  23 years recreation planning, TVA

David R. Gengozian
Position:  Project Manager, Environmental Quality Staff
Education:  B.S., Environmental Health
Experience:  4 years environmental reviews, United Engineers, Inc.
20 years environmental reviews, TVA

Juan E. Gonzalez

Position: Senior Economist for Economic Forecasting

Education: B.A., Economics, Political Science, and Mathematics
M.A., Economics
A.B.D., Economics

Experience: 17 years economic forecasting and economic development, TVA; previous experience includes research in economic forecasting and utility economics, University of Florida

J. Bennett Graham

Position: Senior Archaeologist

Education: M.A., Anthropology

Experience: 22 years archaeology, TVA

Gary D. Hickman

Position: Senior Fisheries Ecologist

Education: M.S., Zoology

Experience: 25 years aquatic ecology, TVA

John J. Jenkinson

Position: Biologist (Malacologist), Water Management

Education: Ph.D., Zoology

Experience: 17 years aquatic endangered species, TVA

J. Don Lokey

Position: Environmental Engineer, Water Management

Education: M.S., Chemical Engineering

Experience: 4 years atmospheric sciences, EPA
15 years atmospheric sciences, TVA

Jack D. Milligan
Position:  Environmental Engineer, Environmental Compliance, Water Management
Education:  M.S., Environmental Engineering
Experience:  20 years water resource engineering, TVA

Roger A. Milstead
Position:  Technical Specialist
Education:  B.S., Civil Engineering
Experience:  20 years water management, TVA

Marshall Ted Nelson
Position:  Technical Specialist, Navigation, Water Management
Education:  Ph.D., Geography
Experience:  12 years navigation planning, 5 years environmental analysis,
5 years public land administration, TVA
3 years topographic engineering, U.S. Army

Charles P. Nicholson
Position:  Zoologist, Land Management
Education:  M.S., Wildlife Management
Experience:  20 years wildlife management, TVA

James N. Niznik
Position:  Project Engineer, Hydrologic Engineering
Education:  B.S., Civil Engineering
Experience:  20 years hydrologic engineering, TVA

Linda B. Oxendine
Position:  Senior NEPA Specialist
Education:  Ph.D., Botany
Experience:  18 years in environmental training and natural resources management, TVA

Kim Pilarski
Position:  Environmental Scientist
Education:  M.S., Geography
Experience:  8 years water resource planning, TVA

Burline P. Pullin
Position:  Wildlife Biologist, Land Management
Education:  M.S., Zoology
Experience:  12 years wading bird specialist, TVA

Ron J. Riberich
Position:  Technical Specialist, Navigation, Water Management
Education:  M.S., Mineral Economics
Experience:  7 years pipeline rate regulation, Federal Energy Regulatory Commission
16 years navigation planning, TVA

Charles R. Tichy
Position:  Historical Architect, Land Management
Education:  B.S., Architecture; M.A., Historic Preservation
Experience:  7 years historical architecture and cultural resource reviews, Tennessee State Historic Preservation Office
17 years historical architecture and cultural resource reviews, TVA

L. Christy Valerio
Position:  Economist
Education:  B.S., Agricultural Economics
M.S., Agricultural Economics
M.S., Public Policy and Public Administration
Ph.D., Economics
Experience:  4 years regional economic forecasting, TVA
Adjunct Professor, Tusculum College

### 6.2 References

Ahlstedt, S. A. 1985. ***Recovery Plan for the Pink Mucket Pearly Mussel, Lampsillis orbiculata*** *(Hildreth, 1928*). U.S. Fish and Wildlife Service, Atlanta, Georgia, 47 pages.

Ahlstedt, S. A. 1989. ***Update of the Watts Bar Nuclear Plant Preoperational Monitoring of the Mussel Fauna in Upper Chickamauga Reservoir***. Technical Report Series, TVA/WR/AB-89/9, TVA Aquatic Biology Department, Norris, Tennessee, 26 pages.

Alexander, L. S. 1994. ***A Phase I Archaeological Reconnaissance of the Chickamauga Lock Replacement Bank Modification, Hamilton County, Tennessee.*** Prepared by Alexander Archaeological Consultants, Chattanooga, Tennessee, under contract No. TV-92843V for Tennessee Valley Authority, Norris, Tennessee.

Baker, T. F. 1993. ***Phytoplankton Dynamics in the Main Channel and Embayments of a Main Stream Reservoir***. Masters Thesis, University of Tennessee at Knoxville, Knoxville, Tennessee.

Bender, M. D., and Proctor, W. D., 1992. ***Upper Tennessee River Navigation Physical Effects Study (Hydrology, Hydrodynamics, Sediments),*** Report No. WR28-4-700-103. Tennessee Valley Authority, Norris, Tennessee.

Biggins, R. G., and R. B. Eager. 1983. ***Snail Darter Recovery Plan***. U.S. Fish and Wildlife Service, Atlanta, Georgia, 46 pages.

Braun, E. L. 1950. ***Deciduous Forests of Eastern North America***. The Blakiston Company, Philadelphia, Pennsylvania.

Brown, A. M., G. D. Jenkins, and G. D. Hickman. 1993. ***Reservoir Monitoring - 1992 Summary of Fish Community Results.*** Tennessee Valley Authority, Chattanooga, Tennessee.

Burns, E. R., A. L. Bates, and D. H. Webb. 1992. ***Aquatic Plant Management Program- Current Status and Seasonal Workplan - 1992***. TVA Water Resources, Muscle Shoals, Alabama.

Burton, M. L. 1993. Railroad Deregulation, Carrier Behavior, and Shipper Response: A Disaggregated Analysis***. Journal of Regulatory Economics,*** Vol. 5, No. 4***.***

Burton, M. L., and W. W. Wilson. 1995. ***Network Pricing and Vertical Foreclosure in Railroad Markets***, working paper, University of Oregon.

Cowardin, L. M., V. Carter, F. C. Goled, E. T. Larowe. 1979. ***Classification of Wetlands and Deep Water Habitats of the United States***, U.S. Fish and Wildlife Publication FWS/OBS-79/31, Washington, D.C.

Dycus, D. L., and D. L. Meinert. 1994. ***Tennessee Valley Reservoir and Stream Quality - 1993 Summary of Vital Signs and Use Suitability Monitoring,*** Vols. I and II, TVA Water Management, Chattanooga, Tennessee.

Federal Energy Management Agency (FEMA). 1987. ***Further Advice on Executive Order 11988 Floodplain Management.*** Interagency Task Force on Floodplain Management, Washington, D.C.

Fenneman, N. M. 1938. ***Physiography of Eastern United States***. McGraw Hill Book Company, Inc., New York, New York.

Fryman, R. J., Ph.D., and J. L. Holland. 1992. ***Phase I Investigations at the Chickamauga Dam, Hamilton County, Tennessee.*** Submitted to Tennessee Valley Authority, Cultural Resources Program, Norris, Tennessee, by Garrow & Associates, Inc., Atlanta, Georgia.

Gooch, C. H., W. J. Pardue, and D. C. Wade. 1979. ***Recent Mollusk Investigations on the Tennessee River, 1978***. Draft Report, TVA Water Quality and Ecology Branch, Muscle Shoals, Alabama, 126 pages.

Hall, G. E., and D. L. Dycus. 1991. ***Reservoir monitoring - 1990 fish tissue studies in the Tennessee Valley in 1989***. TVA Water Resources, Chattanooga, Tennessee, 176 pages.

Hickman, G. D., K. W. Hevel, and E. M. Scott. 1989. ***Density, Movement Patterns, and Spawning Characteristics of Sauger (Stizostedion canadense) in Chickamauga Reservoir, Tennessee - 1988.*** Tennessee Valley Authority, Chattanooga, Tennessee.

Holiday, E. F., et al. 1983. ***Hydrology of Area 20, Eastern Coal Province, Tennessee, Georgia, and Alabama***. Department of the Interior, U.S. Geological Survey Water-Resources Investigation Open-File Report No. 82-440, Nashville, Tennessee.

Jackson, B. W. 1982. ***Soil Survey of Hamilton County, Tennessee***. USDA Soil Conservation Service, in cooperation with the University of Tennessee, Agricultural Experiment Station.

Jenkinson, J. J. 1991. ***Reservoir Vital Signs Monitoring - 1990 Benthic Macroinvertebrate Community Results***. TVA Water Resources Chattanooga, Tennessee, 51 pages.

Jenkinson, J. J. 1993. ***Survey of Freshwater Mussel Stocks Downstream from Chickamauga Dam, Tennessee River Miles 466-470*** (Draft Report). TVA Water Resources, Chattanooga, Tennessee.

Jenkinson, J. J. 1994. ***Freshwater Mollusk Survey at CSX Railroad Bridge, near Bridgeport, Alabama, Tennessee River Mile 414.5***. TVA Water Resources, Chattanooga, Tennessee, 15 pages.

MacDonald, J. M. 1989. Railroad Deregulation, Innovation, and Competition: Effects of Staggers Act on Grain Transportation, ***Journal of Law and Economics***, Vol. 32, No. 1.

Maxwell, R. B. 1992. ***Upper Tennessee River Navigation Study - Water Quality Assessment,*** TVA Occupational Hygiene Department, Memorandum to Anne M. Aiken from R. B. Maxwell, February 24, 1992.

Masters, A. E. 1992. ***Reservoir Vital Signs Monitoring - 1991 Benthic Macroinvertebrate Community Results***. TVA Water Resources, Chattanooga, Tennessee, 72 pages.

Meinert, D. L., S. R. Butkus, and T. A. McDonough. 1993. ***Chickamauga Reservoir Embayment Study - 1990***. TVA Water Resources, Chattanooga, Tennessee, draft report.

National Marine Manufacturers Association. 1988. ***Boating Industry Report***, Chicago, Illinois.

Newstrand, W. M. 1992. "Environmental Impacts of a Modal Shift," ***Marine and Intermodal Transportation: Freight Movement and Environmental Issues*** (Record No. 1333), Transportation Research Board, Washington, D.C., 1992.

O'Bara, C. J. 1990. ***1990 TWRA Creel Survey.*** Tennessee Wildlife Resources Agency, Nashville, Tennessee.

O'Bara, C. J. 1991. ***1991 TWRA Creel Survey.*** Tennessee Wildlife Resources Agency, Nashville, Tennessee.

O'Bara, C. J. 1992. ***1992 TWRA Creel Survey.*** Tennessee Wildlife Resources Agency, Nashville, Tennessee.

O'Bara, C. J. 1993. ***1993 TWRA Creel Survey.*** Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Ortmann, A. E. 1925. The naiad-fauna of the Tennessee River system below Walden Gorge. ***American Midland Naturalist*** 9(7):321-372.

Placke, J. F. and Poppe, W. L. 1980. ***Eutrophication Analysis of Nickajack and Chickamauga Reservoirs; a Report to the Chattanooga Area Waste Management Program Coordination Office*** (208). TVA Division of Water Resources, Chattanooga, Tennessee, 105 pages.

St. John, R. T. 1990. ***Sauger (Stizostedion canadense) abundance and spawning movements in Fort Loudoun Tailwaters, Tennessee.*** Masters Thesis, Tennessee Technological University, Cookeville, Tennessee.

Scott, E. M. and Hevel, K. W. 1993. ***Upstream Movements of Sauger through Navigation Locks in Tennessee River Dams***. TVA Water Management, Norris, Tennessee, draft report.

State of Tennessee. 1990. ***Tennessee State Outdoor Recreation Planning Report,*** Department of Conservation Recreation Services Section, Nashville, Tennessee.

Tennessee Valley Authority. ***Economic Outlook***, various annual issues through 1994. Economic Development Staff, Knoxville, Tennessee.

Tennessee Valley Authority. 1996a. ***Chickamauga Project Engineering Evaluation of Navigation Facility***. Fossil and Hydro Engineering, Chattanooga, Tennessee.

Tennessee Valley Authority. 1996b. ***Upper Tennessee River Navigation Improvement Study: Chickamauga Lock and Dam Economic Benefit and Cost Analysis***. Water Resources Projects and Planning, Knoxville, Tennessee

Todd, R. M. 1990. ***Commercial Fishing Report 1989***. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Todd, R. M. 1991. ***Commercial Fishing Survey 1990***. Tennessee Wildlife Resources Agency, Nashville, Tennessee.

Todd, R. M. 1992. ***Commercial Fishing Report 1991***. *Tennessee Wildlife Resources Agency, Nashville Tennessee.*

Todd, R. M. 1993. ***Commercial Fishing Report 1992***. *Tennessee Wildlife Resources Agency, Nashville Tennessee.*

Todd, R. M. 1994. ***Commercial Fishing Report 1993***. *Tennessee Wildlife Resources Agency, Nashville Tennessee.*

U.S. Army Corps of Engineers. 1988. ***Commodity Traffic and Benefit Study for Navigation Improvements on the Upper Tennessee River***. Navigation Planning Support Center, Huntington, West Virginia.

U.S. Army Corps of Engineers. 1990. ***Forecast of Future Ohio River Basin Waterway Traffic 1986-2050.***. Ohio River Division Navigation Planning Center, Huntington District, Huntington, West Virginia

U.S. Army Corps of Engineers. 1993. ***Upper Tennessee River Navigation Improvement Study Navigation Systems Analysis***. Ohio River Division Navigation Planning Center, Huntington District, Huntington, West Virginia, and the Tennessee Valley Authority, Water Resources Projects and Planning, Knoxville, Tennessee.

U.S. Water Resources Council. 1983. ***Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies***.

Wrenn, W. B. 1986. ***Preoperational Assessment of Water Quality and Biological Resources of Chickamauga Reservoir, Watts Bar Nuclear Plant, 1973 - 1985***. TVA Division of Air and Water Resources, Knoxville, Tennessee, 488 pages.

# APPENDICES

## APPENDIX A

## LIST OF RECIPIENTS OF FINAL EIS

# APPENDIX B

# COMMENTS AND RESPONSES

# APPENDIX C

# GLOSSARY OF TERMS

# APPENDIX D

# PORTAGE AROUND CHICKAMAUGA DAM

## APPENDIX D

## Portage Around Chickamauga Dam

In this alternative, TVA would build a road and the necessary terminal facilities such that traffic could be shipped around Chickamauga Dam. Such a traffic management system would require short truck hauls, two cargo transfers, and some storage at the site. For this portage system to be useful, transportation costs for those commodities projected to use the upper Tennessee River must be lower than that available on competing modes. Data in Tables D-1 and D-2 show that portage at the lock would not be economically viable due to transportation cost. Affected commodities include asphalt and zinc ore which would not use the portage system because of the high transportation cost. Additionally, transshipment results in product shrinkage for zinc shippers, which further raises their transportation cost.

Shown in Table D-1 are comparable freight rates for the movement of zinc ore around the dam from an upstream terminal with a truck haul to Chattanooga. Note that the present rate is $12.30 per ton, as compared to a $23.74 per ton cost if the zinc ore is shipped around the dam. While barge transportation presently saves the shipper $6.56 per ton, closure of the lock and the resultant shipment around the dam would be $4.88 per ton more expensive than shipment by rail. Not included in these data is product loss which occurs when this commodity is moved. Zinc concentrate is a fine powder worth about $400 per ton. It is unavoidable that each time this commodity is moved from one vessel to another, about 1 percent of its volume is lost. A 2 percent loss at Chickamauga Dam would cost present shippers about $2.0 million per year.

Shipment around Chickamauga Dam would also not be a good alternative for asphalt (shown in Table D-2). There would be additional charges (per ton) to process this commodity--$4.50 to transfer to truck, $4.00 for the truck trip above the dam, and $6.00 to transfer to barge storage at the upstream terminal facility. (Note that barges must be loaded from storage tanks and not from trucks and that the $6.00 per ton barge loading charge includes reheating the asphalt held in storage for loading onto barges.) The $18.66 per ton rate presently charged would increase to $37.04 per ton which would be $10.98 per ton greater than the rail rate from Catlettsburg, Kentucky, to Knoxville, Tennessee. Similar analyses for other commodities demonstrate that shipping around the lock by land is not a permanent solution to maintaining navigation on the upper Tennessee River.

Table D-1

COMPARISON OF FREIGHT RATES FOR SHIPMENT OF ZINC ORE WITH PRESENT CONDITIONS AT CHICKAMAUGA LOCK AND CLOSURE OF THE LOCK WITH SHIPMENT AROUND THE LOCK

| Type of Charge | Present Rate with Operating Lock | Expected Rate with Truck Haul Around Lock |
|---|---|---|
| | | |
| Truck to Knoxville | $ 2.25 | $ 2.25 |
| Transfer | 1.65 | 1.65 |
| Barge to River Mile 473—Above Chickamauga | | 8.40 |
| Transfer to Truck | | 2.25 |
| Truck to Chattanooga | | 2.25 |
| Transfer to Barge | | 1.65 |
| Barge to Clarksville, TN | 8.40 | 5.29 |
| Total | $12.30 | $23.74 |
| | | |
| Rail Hodges (Strawberry Plains) to Clarksville | $18.66 | |

Table D-2

COMPARISON OF FREIGHT RATES FOR SHIPMENT OF ASPHALT WITH PRESENT CONDITIONS AT CHICKAMAUGA LOCK AND CLOSURE OF THE LOCK WITH SHIPMENT AROUND THE LOCK

| Type of Charge | Present Rate per Ton with Operating Lock | Expected Rate Per Ton with Truck Haul Around Lock |
|---|---|---|
| | | |
| Barge to Chattanooga | $18.66 | $ 18.66 |
| Transfer to Truck Via Storage | | 4.50 |
| Truck to TN River Mile 473--Above Chickamauga Dam | | 4.00 |
| Transfer to Barge Via Storage | | 6.00 |
| Barge to Knoxville | | 3.88 |
| Unload at Knoxville | 1.00 | 1.00 |
| Total | $19.66 | $ 38.04 |
| | | |
| Rail Catlettsburg to Knoxville | 19.06 | |
| Unload at Knoxville | 7.00 | |
| Total Rail | $26.06 | |